

Taxonomic and Biological Studies of Hawaiian Sphaeroceridae (Diptera)¹

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INTRODUCTION

The members of the family Sphaeroceridae are acalyptrate flies which are basically scavengers both in the larval and adult stages. The adults are frequently found, sometimes in very large numbers, in association with the excrement of various mammals especially cattle, horses and sheep. This association and the fact that many of the common species develop in manure have earned for the Sphaeroceridae the common name, "dung fly."

A review of the literature of Hawaiian Sphaeroceridae has revealed few and scattered studies. Most of these have been concerned only with the recording of species from various islands. The earliest taxonomic studies on these flies were carried out by Grimshaw (1901). In his paper on Hawaiian Diptera published in *Fauna Hawaiiensis*, Grimshaw described 2 new species and recorded 1 other; 1 of the new species subsequently proved to be a synonym. Bryan (1923) recorded an additional species from Oahu. In 1926, Bryan recorded 2 species from Laysan Island; and in 1931 he reported from Kahoolawe Island a species which was the 1st record for that island. In his review of the Hawaiian Diptera, Bryan (1934) included 4 species. Hardy (1952), in his *Additions and Corrections to Bryan's Check List of the Hawaiian Diptera*, and Richards (1952), *Sphaeroceridae (Diptera) from Hawaii*, brought the list of this family up-to-date and included 10 species. An additional new species was described by Richards (1956) from the island of Oahu. Beardsley (1966) recorded a species which was a new record for 4 of the Leeward Hawaiian Islands.

The present study is a taxonomic revision of the species of Sphaeroceridae present in Hawaii and includes a synopsis of biological information gathered through laboratory rearings and field observations. This study involves 22 species, 11 subgenera, and 2 genera. Eleven of the species presented here are new records for Hawaii; 1 of these is described as a new species. Taxonomic determinations are based on descriptions from the literature and from comparisons with specimens previously determined by Richards (1952, 1956, 1963) in the University of Hawaii and the B. P. Bishop Museum collections. Biological information for most of the Hawaiian Sphaeroceridae is new and is presented here for the 1st time.

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MATERIALS AND METHODS

The specimens used for the taxonomic studies in this paper were from collections in the University of Hawaii and the B. P. Bishop Museum. Flies for the biological studies were obtained, for the most part, from cow and horse manure collected in Kailua, Oahu.

Procedure: Manure from field collections was taken into the laboratory where it was placed in several gallon jars (1/4th filled) which were then covered with fine-meshed screen. The jars were periodically examined for emerging flies. Emerged flies were extracted from the jars, killed and prepared for determination. Flies collected in this manner were recorded as reared from manure.

For life cycle studies, small baby food jars and petri dishes were used as rearing containers. Vials of size 2 × 9 cm were also found to be satisfactory for rearing small numbers. These containers were partially filled with manure boiled in water. Boiling served to kill any immature stages which had been previously present in the manure, as well as partially sterilizing the manure. When the medium had completely cooled, adult flies were introduced. In order to obtain a few eggs for examination, the flies in the petri dishes were temporarily removed by opening the dish in a closed plastic bag. When the eggs had been extracted from the medium, the flies in the bag were anesthetized with ether and returned to the petri dish. About 5 days after the initial introduction, the flies were removed from the rearing containers. Collections of larvae and pupae were made by teasing apart and examining the medium under the dissecting microscope. Larvae, pupae, and adult wings, genitalia, and other structures were mounted in Hoyer's mounting medium for examination under the microscope.

Attempts were made to rear Sphaeroceridae in nutrient agar medium, but the results were unsatisfactory. The medium was completely covered with bacterial growth before the entire life cycle of the fly could be completed. Although there were some emergences, the survival rate was extremely low. Most deaths occurred in the egg and larval stages. Furthermore, the flies which emerged from pupae were relatively small, pale and weak. Death followed in a day or 2 after emergence.

Drawings for illustrations presented in this paper were made by the use of a camera-lucida, ocular reticule, or projection prism attached to the eye piece of a compound microscope. Stereoscopic zoom and compound microscopes were utilized for drawings, as well as for determinations of specimens.

TAXONOMY

Names of the flies in this paper are, for the most part, after Richards (1930, 1961, 1963 and 1965), from which were also taken the list of generic and subgeneric names below.

LIST OF GENERIC AND SUBGENERIC NAMES OF SPHAEROCERIDAE THAT OCCUR IN HAWAII

- I. Genus **COPROMYZA** Fallén, 1810:19. Proposed originally without included species; Fallén (1820) included 7 species of which Zetterstedt (1847) designated *C. equina* Fallén, 1820, as the type.

Subgenera:

1. *Copromyza* Fallén. (ss = *Trichiaspis* Duda, 1923. Type species, *C. equina* Fallén, 1820, as designated by Richards (1930)).
 2. *Borborillus* Duda, 1923 : 54. Type *Borborus uncinatus* Duda, 1923, as designated by Richards (1930).
- II. Genus **LEPTOCERA** Olivier, 1813 : 489. Type species, *L. nigra* Olivier, 1813 (mon.).

Subgenera:

1. *Leptocera* Olivier. Syn. *Paracolinellula* Duda, 1924b (*LIMOSINA*). Type species, *Copromyza fontinalis* Fallén, 1827, by designation of Richards (1930).
2. *Rachispoda* Liroy, 1864 : 1116 (as genus). Type *Copromyza limosa* Fallén, 1821 (mon.), by original designation. Syn. *Collinella* Duda, 1918 (*LIMOSINA*) (preocc. Schmidt, 1897 = *Collinellula* Strand, 1926); type species, *Copromyza limosa* Fallén, 1820, by designation of Richards (1930).
3. *Opacifrons* Duda, 1918 : 28 (*LIMOSINA*). Type *Limosina coxate* Stenhammar, 1854, by designation of Spuler (1924b).
4. *Thoracochaeta* Duda, 1918 : 32 (*LIMOSINA*). Type *Borborus zosterae* Haliday, 1833, by designation of Spuler (1925a).
5. *Limosina* Macquart, 1835. Type *Borborus silvaticus* Meigen, 1830, by designation of Westwood (1840). Syn. *Scotophilella* Duna, 1918: type species, *Borborus silvaticus* Meigen, 1830, by designation of Duda (1924a).
6. *Poecilomella* Duda, 1925 : 78. Type *Borborus punctipennis* Wiedemann, 1824, by designation of Richards (1930).
7. *Pachylarsella* Richards, 1963 : 124. Type *Leptocera (Limosina) pachypus* Richards, 1956, by designation of Richards (1963).
8. *Trachyopella* Duda, 1918 : 34, 195 (*LIMOSINA*). Type *Limosina melania* Haliday, 1836, by designation of Spuler (1925a).
9. *Coproica* Rondani, 1861 : 10 (as genus). Proposed to replace *Heteroptera* Macquart, 1835 (preocc. Rafinesque, 1814). Type species, *Limosina pusilla* Meigen, 1830 (aut; misident.) = *acutangula* (Zetterstedt), 1847. Syn. *Coprophila* Duda, 1918 : 45 (*LIMOSINA*); type species, *Borborus vagans* Haliday, 1833, by designation of Spuler (1925a).

KEY TO GENERA AND SUBGENERA OF HAWAIIAN SPHAEROCERIDAE

Since 8 of the subgenera below are represented in Hawaii by a single

Distribution of Hawaiian Sphaeroceridae

	Hawaii	Kauai	Lanai	Maui	Oahu	Molokai	Other Places
I. Genus <i>COPROMYZA</i> Fallén							
1. <i>C. (Copromyza) equina</i> Fallén	×	×		×		×	Europe, North America
2. <i>C. (Borborillus) sordida</i> Zetterstedt	×	×		×	×	×	Kahoolawe Is., Europe, Africa, North America, India.
II. Genus <i>LEPTOCERA</i> Olivier							
3. <i>L. (Leptocera) abdominiseta</i> Duda	×	×	×	×	×	×	S. America
4. <i>L. (Rachispoda) downesi</i> Richards			×	×	×		Laysan Is., Midway Is., Scotland, North America, Micronesia.
5. <i>L. (Opacifrons) aequalis</i> (Grimshaw)	×	×	×	×	×	×	
6. <i>L. (Thoracochaeta) brachystoma</i> (Stenhammar)				×	×		Lisiansky Is., Laysan Is., Midway Is., Cosmopolitan.
7. <i>L. (Poecilosomella) punctipennis</i> (Wiedemann)	×	×	×	×	×	×	Laysan Is., Cosmopolitan.
8. <i>L. (Pachytarsella) pachypus</i> Richards					×		
9. <i>L. (Limosina) bifrons</i> (Stenhammar)	×	×		×	×	×	Cosmopolitan.
10. <i>L. (Limosina) brevicostata</i> var. <i>rufifrons</i> Duda					×		Formosa, N. Guinea, Abyssinia, E. India, Congo, Micronesia.
11. <i>L. (L.) pectinata</i> sp. n.	×	×		×	×	×	
12. <i>L. (L.) brevivenuosa</i> Tenorio	×			×	×		
13. <i>L. (L.) heteroneura</i> (Haliday)	×				×	×	Europe, Africa, N. America, Formosa
14. <i>L. (L.) mirabilis</i> (Collin)	×	×		×	×	×	Europe, N. America.
15. <i>L. (L.) empirica</i> (Hutton)				×			Europe, Iceland, N. Zealand, Canada, Juan Fernandez Is., Falkland Is., Campbell Is.
16. <i>L. (Trachypella) hardyi</i> Tenorio	×		×		×		Micronesia (?)
17. <i>L. (T.) atomus</i> Rondani			×		×		Europe, Canary Is., Madeira, Belgian Congo, Micronesia.
18. <i>L. (T.) obliqua</i> Richards					×		Micronesia.
19. <i>L. (Coproica) acutangula</i> (Zetterstedt)					×		Europe, Madeira, Belgian Congo, N. America.
20. <i>L. (C.) ferruginata</i> (Stenhammar)					×		Cosmopolitan.
21. <i>L. (C.) hirtula</i> (Rondani)	×	×			×	×	Cosmopolitan.
22. <i>L. (C.) vagans</i> (Haliday)					×		Cosmopolitan.

species, it was felt necessary to erect a key to genera and subgenera separate from a key to species. This allows one to separate the subgenera using subgeneric characters and the species using specific characters, which would be difficult if the subgenera and species were all in the same key.

1. Veins M_{1+2} and M_{3+4} both evanescent, never fully pigmented much beyond m crossvein; anal cell absent, anal vein only faintly visible; hind tibia lacking ventral apical curved spur; propleura not hairy3. Genus *Leptocera* Olivier
- Vein M_{1+2} always reaching the margin of the wing and completely pigmented; anal cell and anal vein present; hind tibia with ventral apical curved spur (Fig. 1b); propleura hairy2. Genus *Copromyza* Fallén
- 2(1) Scutellum with 4 marginal bristles, without marginal hairs; hind tibia with anteroventral bristle at about apical 3rd; male front basitarsus with a ventral hook at apex (Fig. 1c).....Subgenus *Borborillus* Duda
- Scutellum with fine hairs (Fig. 1a) in addition to 4 marginal bristles; hind tibia without anteroventral bristle at apical 3rd; male front basitarsus lacking ventral hook at apex.....Subgenus *Copromyza* Fallén
- 3(1) Scutellum densely covered with more or less uniformly short bristles (Fig. 7c).....Subgenus *Coproica* Rondani
- Scutellum with marginal bristles only, or if bristles occur on the disc, they are not uniformly short and not densely covering the scutellum.....4
- 4(3) Frons and mesonotum with white spots, especially at base of major bristles; wings with dark spots on anterior veins.....Subgenus *Poecilosomella* Duda
- Frons and mesonotum lacking white spots; wings lacking dark spots on veins..... 5
- 5(4) Middle tibia with an apical ventral bristle; middle basitarsus lacking ventral bristle near base..... 8
- Middle tibia lacking apical ventral bristle, preapical ventral bristle usually present; middle basitarsus with a distinct ventral bristle near base..... 6
- 6(5) Scutellum with 6 to 8 marginal bristles; middle tibia with a preapical ventral bristle; middle trochanter with a long up-curved anteroventral bristle..... 7
- Scutellum with only 4 marginal bristles; middle tibia lacking the preapical ventral bristle; middle trochanter lacking long upcurved bristleSubgenus *Opacifrons* Duda
- 7(6) Scutellum with bristles on the disc; anterior pair of dorsocentral bristles directed inward.....Subgenus *Rachispoda* Lioy
- Scutellum lacking bristles on the disc; anterior pair of dorso-

- centrals not directed inward; with 4 pairs of marginal scutellar bristles, the anterior pair hair-like.....Subgenus *Leptocera* Olivier
- 8(5) Frons with only 1 pair of interfrontal bristles; middle basitarsus thickened; wing with the posterior corner of discal cell rounded.....Subgenus *Pachytarsella* Richards
- Frons with more than 2 pairs of interfrontal bristles; middle basitarsus not thickened..... 9
- 9(8) Dorsocentral bristles in more than 2 pairs, the anterior pair directed inward; antennae directed outward and widely separated, the distance between them about equal to 1 antennal length.....Subgenus *Thoracochaeta* Duda
- Dorsocentral bristles in not more than 2 pairs, the anterior pair not directed inward; antennae varied.....10
- 10(9) Frons with a row of bristles about midway between the interfrontal and the orbital bristles (Fig. 6a); R_{4+5} extremely curved forward, meeting the costa well before the wing apex; costa extending considerably beyond the apex of R_{4+5}
-Subgenus *Trachyopella* Duda
- Frons lacking the row of bristles midway between the interfrontal and the orbital bristles, minute hairs may be present much closer to the orbitals than to the interfrontals; costa not extending considerably beyond the apex of R_{4+5}
-Subgenus *Limosina* Macquart

KEY TO THE SPECIES OF HAWAIIAN SPHAEROCERIDAE

Most of the 22 species have distinct, easily observable characters, and thus, possibly with 1 or 2 exceptions, can be distinguished from one another without great difficulty. In the key, only characters which can be perceived easily are used. Only in cases where 2 species closely resemble each other are abdominal characters, which are usually obstructed from view by the wings and legs, utilized.

1. Anal cell and anal vein present; M_{1+2} completely pigmented and extending to the margin of the wing. Hind tibia with ventral apical curved spur (Fig. 1b). Propleura hairy..... 2
- Anal cell and anal vein absent; M_{1+2} never pigmented much beyond the m crossvein. Hind tibia without ventral, apical, curved spur. Propleura not hairy..... 3
- 2(1) Face, genae, and anterior margin of frons, yellowish to reddish. Thorax with sternopleura, 3/4ths of mesopleura, and scutellum shining black. Hind tibia with an anterior apical bristle about 1/2 as long as the ventral apical curved spur (Fig. 1b); second tarsomere about as broad as basitarsus. Body length greater than 3 mm...1. *Copromyza* (*Copromyza*) *equina* Fallén

- Face, genae, and frons dark grey to black; genae ventrally with a tomentous area, $1/2$ as high as gena between the eye and buccal margin and extending from the vibrissa to about posterior $1/4$ th of gena. Thorax with 2 grayish vittae just inside the dorsocentral lines. Sternopleura shining black, mesopleura and scutellum dull gray. Hind tibia lacking the anterior apical bristles; 2nd tarsomere slender. Body length less than 3 mm.....2. *Copromyza* (*Borborillus*) *sordida* (Zetterstedt)
- 3(1) Disc of scutellum completely covered with relatively uniform short bristles (Fig. 7c). Costa always extending beyond the apex of R_{4+5} (Fig. 7a, d).....19
- Disc of scutellum never completely covered with short bristles. Costa varied..... 4
- 4(3) Frons and mesonotum with whitish spots. Wing with dark areas at apex of R, on R opposite base of R_{4+5} , apex of R_{2+3} , and base of R_{4+5} . R_{4+5} curved forward, M_{1+2} weakly sinuate. Legs brown-banded7. *Leptocera* (*Poecilomella*) *punctipennis* (Wiedemann)
- Frons and mesonotum lacking whitish spots. Wing without dark spots on veins, and legs not banded..... 5
- 5(4) Middle tibia with distinct ventral apical bristles..... 8
- Middle tibia without ventral apical bristle..... 6
- 6(5) Scutellum with more than 4 marginal bristles. Middle trochanter with long upcurved ventral bristle. Middle tibia with a preapical ventral bristle..... 7
- Scutellum with only 4 marginal bristles. Middle trochanter lacking a long upcurved ventral bristle. Middle tibia without a preapical ventral bristle. Middle basitarsus with a ventral bristle near the base. Apex of M_{1+2} slightly bent backward. Frons and antennae black. Male with rows of comb-like ventral bristles on basal $1/2$ of middle femur and apical $1/2$ of middle tibia.....6. *Leptocera* (*Opacifrons*) *aequalis* (Grimshaw)
- 7(6) Anterior pair of dorsocentral bristles directed inward. Disc of scutellum with a fairly long pair of bristles in addition to a few minute ones. Male middle femur with a short but strong ventral bristle near the base.....4. *Leptocera* (*Rachispoda*) *downesi* Richards
- Anterior pair of dorsocentrals not directed inward. Scutellum lacking bristles on disc; with 8 marginal bristles, the anterior pair hairlike. Male middle femur without the ventral bristle near the base.....3. *Leptocera* (*Leptocera*) *abdominiseta* Duda
- 8(5) Frons with only 1 pair of interfrontal bristles. Middle basitarsus thickened. Wing with short bristles on first costal sector; posterior corner of discal cell rounded; anal vein (faintly visi-

- ble) rounded posteriorly. Male middle tibia with a group of ventral bristles...8. *Leptocera* (*Pachytarsella*) *pachypus* Richards
 Frons always with more than 1 pair of interfrontal bristles. Middle basitarsus not thickened. Posterior corner of discal cell not rounded..... 9
- 9(8) Thorax with 4 pairs of small dorsocentral bristles, the 2 anterior pairs directed inward. Antennae divergent and widely spaced, the distance between their bases about equal to 1 antennal length. Eyes relatively small, appearing granulated. Small brown species breeding in seaweed.....
5. *Leptocera* (*Thoracochaeta*) *brachystoma* (Stenhammar)
 Thorax with not more than 2 pairs of dorsocentral bristles, and none directed inward. Antennae and eyes varied.....10
- 10(9) Frons always with a row of small bristles about midway between the interfrontal and orbital bristles (Fig. 6a). R_{4+5} extremely curved forward thus meeting the costa much before the apex of wing; costa continuing considerably beyond apex of R_{4+5} . Very small species with small eyes which are sometimes hairy17
 Frons lacking the row of bristles midway between the interfrontal and orbital bristles. R_{4+5} not extremely curved forward. Costa not continuing considerably beyond the apex of R_{4+5} 11
- 11(10) Vein R_{4+5} curved forward.....12
 Vein R_{4+5} straight, at most apex bent forward.....15
- 12(11) Vein R_{2+3} short, its length less than 1/2 the length of R_{4+5} ; sometimes sinuate apically. Second costal sector scarcely 1/2 the length of the 3rd sector. Male middle tibia at apical 1/3rd with irregular rows of comb-like bristles. Female middle tibia relatively bare on posterior face. Wings fumose.....
12. *Leptocera* (*Limosina*) *brevivenosa* Tenorio
 Vein R_{2+3} more than half as long as R_{4+5} . Second costal sector longer than 1/2 the length of 3rd sector. Middle tibiae of ♂ and ♀ not modified as above.....13
- 13(12) Hind tibia with long curved ventral bristle arising just beyond the middle (Fig. 4f). R_{4+5} meeting the costa very close to the wing apex. Female cerci each with a dorsal black bristle (Fig. 4h-j). Small black species
14. *Leptocera* (*Limosina*) *mirabilis* (Collin)
 Hind tibia lacking long curved ventral bristle. R_{4+5} meeting the costa before the apex of wing. Female cerci without dorsal black bristles.....14
- 14(13) Male 5th abdominal sternite bordered posteriorly with black, spinelike, closely placed bristles arranged like a comb (Fig.

- 3a, c); these bristles extend along the entire posterior margin.
Male clasper as in Figure 9e.....11. *Leptocera*
(*Limosina*) *pectinata* sp. n.
- Male 5th abdominal sternite bordered by 2 separate rows of minute comb-like bristles which do not extend along the entire posterior margin (Fig. 2c). Female of this species very close to the female of above.....10. *Leptocera* (*Limosina*)
brevicostata var. *rufifrons* Duda
- 15(11) Hind femur with a preapical dorsal bristle. Eyes relatively small, longest diameter less than 1/2 the height of head. Vibrissa angle with 1 long and 1 short bristle; 1 moderately long jowlar bristle, about 3/4ths as long as longest vibrissa, directed anterodorsal. Male middle femur basally with tuft of ventral bristles; tibia at apical 1/2 with irregular rows of comb-like ventral bristles.....15. *Leptocera*
(*Limosina*) *empirica* (Hutton)
- Hind femur lacking preapical dorsal bristle. Longest diameter of eyes more than 1/2 the height of head. One vibrissa bristle; jowlar bristles weak. Male middle femur and tibia not modified as above.....16
- 16(15) Crossveins *r-m* and *m* situated very close together, distance between them less than 1/2 length of *m*. R_{4+5} bent forward at apex and overpassed a short distance by the costa. Frons uniformly brown to dark brown.....13. *Leptocera* (*Limosina*)
heteroneura (Haliday)
- Crossveins *r-m* and *m* situated farther apart than half the length of *m*. R_{4+5} straight, not overpassed by the costa. Frons yellow anteriorly, dark posteriorly. Male hind femur with a row of ventral bristles on basal 1/2 (Fig. 1e); tibia with irregular rows of comb-like ventral bristles on apical 1/2 (Fig. 1e).....
.....9. *Leptocera* (*Limosina*) *bifrons* (Stenhammar)
- 17(10) Eyes hairy (Fig. 6a). R_{2+3} strongly bent forward at base of fork, length about a third the length of R_{4+5} . Second costal sector scarcely 2/3rds the length of the 3rd sector. Hind tibia lacking preapical dorsal bristle.....
.....17. *Leptocera* (*Trachyopella*) *atomus* (Rondani)
- Eyes bare. R_{2+3} not strongly bent forward, either running almost parallel to, or very close to, the costa. Second costal sector longer or only slightly shorter than 3rd sector. Hind tibia with a preapical dorsal bristle.....18
- 18(17) Wing with R_{2+3} arched and running extremely close to costa; apex of R_{2+3} not bent or curved forward, gradually approaching the costa, running very close to the costa for a short distance. Second costal sector as long as or shorter than 3rd

- sector. Thorax with 2 rows of acrostichals between the 2 posterior dorsocentral bristles.....
-16. *Leptocera* (*Trachyopella*) *hardyi* Tenorio
- Vein R_{2+3} running almost parallel to costa, but not very close to it; apex of R_{2+3} bent forward. Second costal sector as long as or longer than 3rd sector. Thorax with 3 or more rows of acrostichals between the 2 posterior pairs of dorsocentral bristles.....18. *Leptocera* (*Trachyopella*) *obliqua* Richards
- 19(3) Second costal sector scarcely as long as 3rd sector (Fig. 7e). Frons anterior margin red-brown, vertex black. Section of costa overpassing apex of R_{4+5} is more than 1/2 the length of first section of R_{4+5}21. *Leptocera* (*Coproica*) *hirtula* (Rondani)
- Second sector of costa distinctly longer than 3rd sector (Fig. 7a) 20
- 20(19) Thorax reddish brown. Sternopleura with 3 bristles. First costal sector with relatively long bristles (Fig. 7a).....
-20. *Leptocera* (*Coproica*) *ferruginata* (Stenhammar)
- Thorax dark or black. Sternopleura with only 2 bristles. First costal sector with short bristles21
- 21(20) Sternopleura bristles small, about 1/2 as long as the backwardly directed humeral bristle. R_{4+5} beyond *r-m* crossvein straight. Male with front basitarsus enlarged apically; hind basitarsus apically with a ventral spine-like projection; wing vein M_{1+2} strongly bent posteriorly and forming a more or less straight line with *m* crossvein, the margin opposite the apex of the discal cell with a row of long upcurved bristles
-19. *Leptocera* (*Coproica*) *acutangula* (Zetterstedt)
- Sternopleura with 2 almost equally long bristles, widely spaced. R_{4+5} slightly curved forward; costa ending before the apex of the wing. Male with front and hind basitarsi and wings not modified.....22. *Leptocera* (*Coproica*) *vagans* (Haliday)

Genus **COPROMYZA** Fallén

This genus is represented in Hawaii by 2 species and 2 subgenera.

This genus can be separated from the other genus which occurs in Hawaii by the presence of a ventral curved apical spur on the hind tibia, presence of anal cell and anal vein, vein M_{1+2} completely pigmented beyond *m* crossvein and extending to the margin of the wing, and propleura hairy.

Subgenus *Copromyza* Fallén

1. **Copromyza** (**Copromyza**) **equina** Fallén, (Fig. 1a, b).

Copromyza equina Fallén, 1820 : 6.

Borborus (*Trichiaspis*) *equinus*, Duda, 1923a : 55.

Borborus (Borborus) equinus, Spuler, 1925b : 13.

This species was originally described from Sweden.

Sternopleura shining black, except for a narrow strip along the dorsal margin. Mesopleura with the dorsal and the posterior 1/4th dull, the rest shining black like the sternopleura. Propleura uniformly hairy, without distinct long bristle-like hairs. Margin of scutellum with several long hairs in addition to 4 marginal bristles. Scutellum shining. Body length about 3.9 mm. Male right clasper (Fig. 8a).

Distribution: Europe, N. America, Hawaii.

Specimens examined: 171 ♂, 183 ♀. Islands: Hawaii; Kilauea, Wood above Mac. & D. Ranch, Hopuwai, Lake Waiau, Mauna Kea, Kona near Pawaina, N. slope Hualalai, Kahua, Hamakua Trail, Honaunau Forest Reserve, Kohala Mts., Keanakolu. Kauai; Kokee, Kaholuamanu. Maui; Kula Pipeline, Holua on Haleakala Crater, Puu Nianiau, Haleakala, Auwahi, Ukelele Camp on Pig Hunters' Trail, Puu Kukui, Honomanu Val. Trail, Kolekole Pk. Molokai; Kawela Gulch.

Subgenus *Borborillus* Duda

2. *Copromyza (Borborillus) sordida* Zetterstedt, (Fig. 1c).

Copromyza sordida Zetterstedt, 1847 : 2484.

Borborus bilineatus Grimshaw, 1901 : 75.

Borborus (Borborillus) marmoratus Becker of Spuler, 1925b : 13.

Borborillus sordidus, Hackman, 1965 : 489.

(For a more complete list of synonyms of this species, see Richards, 1962.)

This species was originally described from Sweden.

Sternopleura shining beneath, mesopleura dull gray except for a small area along the anteroventral corner. Propleura with one long bristle in addition to the small hairs. Thorax with a pair of gray lines between the dorsocentral lines. Scutellum dull, with 4 marginal bristles, lacking hairs. Male right clasper (Fig. 8c)

Distribution: Europe, Africa, Canary Is., N. America, E. India, Bermuda, Hawaii.

Specimens examined: 93 ♂, 66 ♀. Islands: Hawaii; Waipio Bay near Kukuiahae, Puu Kalapa Pond, Keanakolu, Kohala Mts., Kahua, Kahuku Ranch. Kauai; Kokee, Poomau Valley. Maui; Puu Nianiau, Olinda, Kahoolawe Is. off Maui. Oahu; Honolulu, Wailupe, Lualualei, U. H. Dairy Farm, Puu Kaaumakua, Kailua. Molokai; Halawa Valley, Maunahui.

GENUS *LEPTOCERA* OLIVIER

The names *Leptocera* Olivier and *Limosina* Macquart have been in a state of confusion since 1938.

Richards (1930), in his paper on British Sphaeroceridae, placed *Limo-*

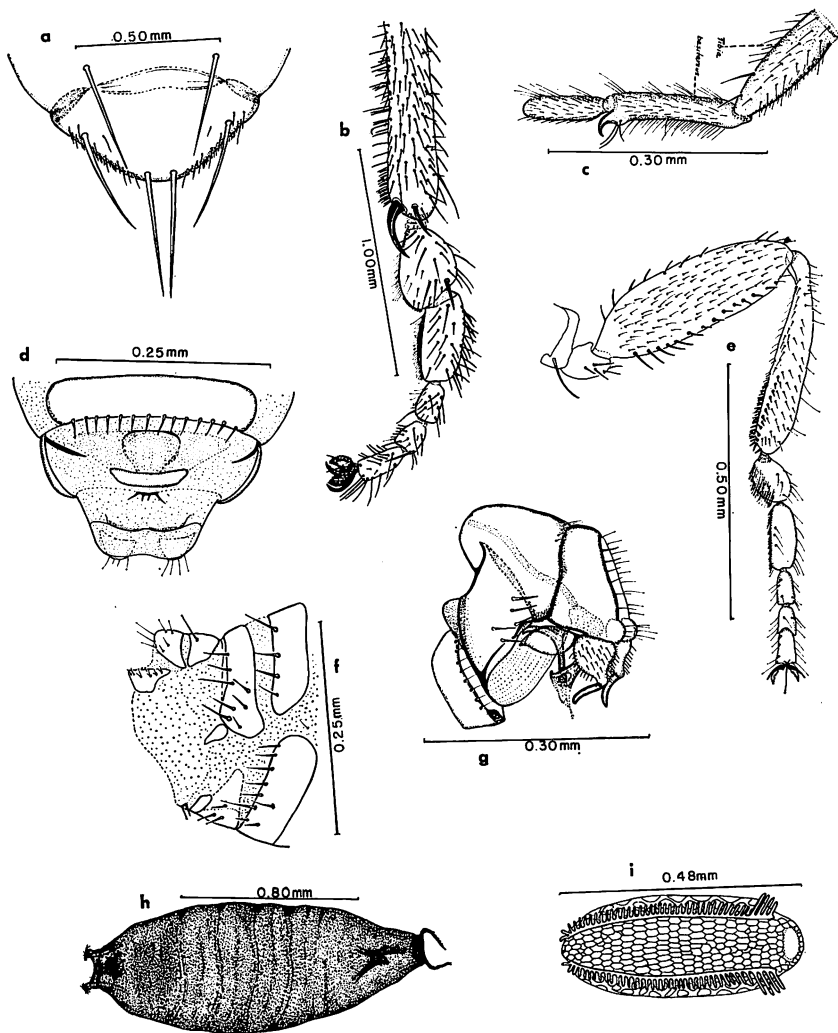


FIG. 1. *Copromyza equina* Fallén: a. scutellum (dorsal view), b. hind tibia and tarsi (anterior view). *Copromyza sordida* Zetterstedt; c. front basitarsus (posterior view). *Leptocera bifrons* (Stenhammar); d. ♀ genitalia (ventral view), e. ♂ hind leg (anterior view), f. same as d (from right side), g. ♂ genitalia (from left side), h. pupa (ventral view), i. egg (dorsal view)

sina Macquart as a subgenus of *Leptocera* Olivier. In 1952, Richards elevated *Limosina* Macq. to a generic position replacing *Leptocera*, following Duda (1938, p. 14) who claimed that "*Leptocera* Olivier, 1813, was founded on a species of chloropid" (Richards, 1952, p. 429). However, Duda's claim was contested by C. W. Sabrosky (a Chloropidae specialist), and, consequently, Richards proposed that *Leptocera* Olivier should be retained

as the genus (Richards, 1956). This is the present status.

The genus is represented in Hawaii by 1 variety, 20 species and 9 subgenera. The majority of these species are found on or about cow manure. One is described here as a new species.

This genus can be separated from *Copromyza* by the absence of the anal vein and anal cell, M_{1+2} never reaching the wing margin, completely pigmented (pigmented only a short distance beyond *m* crossvein), the propleura bare or sometimes with one or two minute hairs, and the hind tibia lacking a ventral curved apical bristle.

Subgenus *Leptocera* Olivier

3. **Leptocera (Leptocera) abdominiseta** Duda.

Leptocera (Paracollinella) abdominiseta Duda, 1925 : 52.

Limosina (Paracollinella) abdominiseta, Richards, 1952 : 430.

This species was originally described from Paraguay, Brazil, Bolivia, and Chile.

Head: Anterior half of frons reddish, vertex brown to black. Interfrontal line gray pollinose. Face yellowish, concave below the antennae. Genae yellowish. Antennae reddish to dark brown. Vibrissal angle with one long bristle, the longest jowler bristle about 1/2 as long as the vibrissa bristle. **Thorax:** Humeral callus with 1 long backwardly directed and 2 short inwardly directed bristles. Sternopleura with 2 bristles, the anterior about a third as long as the posterior one. Scutellum with disc bare, margin with 8 bristles, the anterior pair hair-like. Middle trochanter apically with a ventral upcurved bristle, tibia with a mid-ventral and a preapical ventral bristle, basitarsus with a ventral bristle near the base. **Abdomen:** Black. Apical corners of 5th and 6th segments appear hairy. Right clasper of ♂ as in Fig. 8b.

Distribution: Paraguay, Brazil, Bolivia, Chile, Peru, Hawaii.

Specimens examined: 300 ♂, 293 ♀. **Islands:** Hawaii; widespread. Kauai; widespread. Lanai; Lanaihale. Maui; Paliku in Haleakala crater, Keanae, Kanaloa, Waikamoi. Oahu; widespread. Molokai; Puu Kolekole, Manawainui Val., Kalaupapa Lookout, Halawa, Mauna Loa, Kalae.

This species appears to be widespread in most of the 6 major islands.

Subgenus *Rachispoda* Lioy

4. **Leptocera (Rachispoda) downesi** Richards.

Leptocera downesi Richards, 1944 : 137.

Limosina (Collinellula) downesi, Richards, 1952 : 430.

Leptocera (Leptocera) downesi, Richards, 1965 : 721 (apparently this name was erroneously entered in the catalogue of North American Diptera).

This species was originally described from Glasgow, Scotland, taken

from a ship in large numbers "breeding in damp wheat from Argentina" (Richards, 1952). According to Richards (1952), the specimens which he examined from Hawaii "are rather smaller but quite similar and have the same type of ♂ genitalia...the curvature of R_{4+5} varies somewhat...straighter than usual." However, these differences are minor, and, for this reason, the Hawaiian specimens with these slight variations are considered to be the same as Richards (1944) species.

Head: Frons, face and genae brown to black with gray pollinose. Antennae with 2nd segment black, 3rd segment dark brown and pubescent, arista short pubescent and about 5 times as long as the 3rd segment. Vibrissa angle with 1 long and 1 short ventral bristle, 1 upwardly directed jowler bristle about equal to the longest vibrissa. *Thorax:* Humeral callus with 2 inwardly directed bristles, the outer 1 shorter and 1 backwardly directed bristle. Two pairs of fairly long and 3 pairs of short dorsocentrals, the anterior and posterior pairs longest. Two to 7 rows of short acrostichals behind the suture, 7 to 9 rows in front. Disc of scutellum with a pair of moderately long and 3 to 5 pairs of very short bristles anterolateral to the long pair; 2 pairs of long and a pair of moderately long marginal bristles. Sternopleura with 2 bristles, the anterior 1 weaker. Front femur dorsally with a row of 4 widely spaced bristles; a row of 3 to 4 widely spaced posteroventral bristles on apical 1/2; at base with a moderately long hair-like ventral bristle. Middle trochanter with a long curved ventral apical bristle; femur with a row of comb-like anteroventral bristles on apical half, in ♂ with a ventral bristle near the base; tibia with a mid-ventral and a preapical ventral bristle; basitarsus with a relatively long ventral bristle near the base, apically with 4 to 5 bristles. Hind tibia dorsally with long and widely spaced hair-like bristles. *Wing:* First costal sector with long bristles; 2nd sector slightly less than twice as long as 3rd sector; R_{2+3} curved forward at apical 1/4th; R_{4+5} slightly curved forward; unpigmented portion of M_{1+2} ending at the wing margin farther from wing apex than end of R_{4+5} . *Abdomen:* Dull black. Apical corners of 5th and 6th tergites with long hair-like bristles. Anal split of ♂ broadly oval, surrounded by fine hairs. Body length of ♂ about 1.70 mm.; wing about 1.60 mm.; ♀ body length about 1.90 mm.; wing about 1.80 mm. Male right clasper (Fig. 8d).

Distribution: Scotland (ship from Argentina), N. America, Micronesia, Hawaii.

Specimens examined: 54 ♂, 82 ♀. Islands: Kauai; Mana, Boham A.F.B. Maui; Waihee Beach. Oahu; widespread. Laysan Is., Midway Is.

It appears that this species is widespread on the island of Oahu only. In 1966, it was caught in Public Health light traps from various localities on Oahu; however, it has not been found in abundance from any particular locality.

Richards (1963, p. 115) reported two ♀ of this species, which were captured on a Philippine clipper on Guam, Mariana Is. No further record of this species has been reported from Micronesia.

Subgenus *Opacifrons* Duda

5. **Leptocera** (**Opacifrons**) **aequalis** (Grimshaw).

Limosina aequalis Grimshaw, 1901 : 76.

Limosina (*Opacifrons*) *aequalis*, Richards, 1952 : 430.

This species was originally described from the island of Oahu. Richards (1952) recorded it from the island of Hawaii. It has not yet been recorded outside of the Hawaiian Islands.

The following description is taken from Richards (1952, p. 431):

A smaller but distinct outwardly directed bristle inside each of the two outwardly directed inferior orbitals; antennae strongly divergent, arista with moderately long pubescence, three times as long as third segment; two pairs of strong dorsocentrals and acrostichals, all minute; mid-femur in male with a weaker anteroventral and a stronger posteroventral comb-like row of about twelve short, stout bristles; mid-tibia in male with a small antero-dorsal bristle at 1/4, a pair of bristles at 3/4, and somewhat stronger anterodorsal bristle just below them, ventrally with very short, comb-like bristles on apical half, in female similar to male but ventral comb absent. Wings with second sector of costa distinctly longer than third, costa extending a very short distance beyond R_{4+5} , which is almost straight and ends rather nearer the wing-tip than does the fold-like extension of M_{1+2} ; abdomen in female with no long bristles, last tergal plates strongly shining, each with a stout, spike-like bristle, in male with reflexed margins of tergites 3 and 4 with long, dense, hair-like bristles, genitalia rather large, with no long bristles, anal split rather widely oval, surrounded by close-set short bristles, genital forceps apparently short, fifth sternite asymmetrically emarginate, on left side with a projecting lobe bearing a comb of black bristles. (Male right clasper as in Fig. 9a.)

Distribution: Hawaii.

Specimens examined: 84 ♂, 70 ♀. Islands: Hawaii; Kulani, Kaiolena on Kohala Mts., Upper Olaa Forest, Honokaa, Akaka Falls, Pauahi. Kauai; Waiakaoli Valley. Lanai; Lanaihale. Maui; Haleakala, Kula Pipeline, Paliku on Haleakala, Waikamoi, Puu Niauniau, Kipahulu Valley. Oahu; Kamokuiki Val. (about water pools), Makaleha, Manoa Valley, Manoa Falls, Mt. Kaala, Mt. Tantalus. Molokai; Kainalu (on window), Puu Kolekole, Manawainui Valley.

Subgenus *Thoracochaeta* Duda

6. **Leptocera** (**Thoracochaeta**) **brachystoma** (Stenhammar) (Fig. 5a-f).

Limosina brachystoma Stenhammar, 1854 : 393.

Limosina andaluciaca Strobl, 1900 (Duda, 1938 : 98).

This species was originally described from Sweden. It is similar to 2 or 3 other Hawaiian species, but it can easily be distinguished by the presence of 2 pairs of incurving presutural dorsocentral bristles.

Relatively small dull brown to dark brown species. *Head*: Ocelli widely separated, ocellar triangle with 2 relatively strong and several

randomly placed small bristles. Antennae strongly divergent with arista more than 4 times as long as the pubescent 3rd segment; pubescence on 3rd segment about as long as the pubescence on the arista, but more dense. Eyes appear granulated and small in relation to the head. *Thorax*: 4 pairs of short dorsocentrals, 2 pairs in front of suture directed inward. Humeral callus with 1 bristle directed posteriorly. Middle tibia with a ventral apical bristle, dorsally with a pair of bristles at about basal 1/4th and a longer pair at apical 1/3rd. First costal sector of wing with relatively long bristles, more than twice as long as bristles on 2nd sector; R_{2+3} bent forward at apex; R_{4+5} straight and meeting the costa slightly before the apex of wing. Body and wings about equal in length, 0.90 mm to 1.20 mm. Male right clasper (Fig. 9b).

Distribution: Europe, N. America, Bermuda, Seychelles, Arabia, Mediterranean Region, Hawaii.

Specimens examined: 62 ♂, 79 ♀. Islands: Maui; Hana. Oahu; Kailua (in seaweed), Waimanalo (in seaweed), Honolulu, Haleiwa, Ewa, U. H. Campus (light trap). Lisiansky Is. (in seaweed), Laysan Is., Midway Is.

Subgenus *Poecilosomella* Duda

7. **Leptocera** (**Poecilosomella**) **punctipennis** (Wiedemann).

Borborus punctipennis Wiedemann, 1824 : 599.

Limosina venalicia Osten-Sacken, of Grimshaw, 1901 : 75.

Leptocera (*Scotophilella*) *venalicia* Osten-Sacken, of Spuler, 1925c : 71, 80.

Limosina (*Poecilosomella*) *punctipennis*, Richards, 1952 : 430.

Generally red-brown to dark brown, spotted with white pollinose on head and thorax. The abdomen appears white-banded, at least on the tergites. *Head*: Frons predominantly reddish, lighter along the anterolateral border; white spots at base of major bristles. Interfrontal with 2 to 3 pairs of hair-like bristles, the anteriormost and the middle pair farther apart than the middle pair is from the posterior pair. Ocellar bristles long, slightly longer than the orbitals and slightly shorter than the inner verticals. Post ocellar with 3 to 4 pairs of minute bristles. Face shining, paler along the margin. One vibrissa bristle, more than twice as long as the longest jowlar. Antennae with the 1st segment dull brown; 2nd segment black on the dorsal part and bordered apically with short bristles; 3rd segment dark brown and short pubescent; arista subapical, short pubescent, and about 5 times as long as the 3rd segment. *Thorax*: Humeral callus with minute bristles and a single long bristle directed backward. Mesonotum with white spots at bases of major bristles and along the mid line. Scutellum at basal 1/4th with two spots, 2 more spots apically at bases of the apical bristles. Four marginal scutellar bristles. Dorsocentral with 2 pairs of bristles. Sternopleura with 2 small bristles. *Legs*: Anterior coxa

black, middle and hind coxae yellow; tibiae, tarsi and apex of femora brown-banded. Middle tibia with short spinelike bristles bordering the apex, no long ventral apical bristle. Male front femur and tibia densely haired ventrally. *Wings*: Dark spots on humeral crossvein, on costa at apex of R_1 , on R_1 at level of fork of R_{2+3} and R_{4+5} , at fork of R_{2+3} and R_{4+5} , and apex of R_{4+5} . Vein R_{2+3} bent forward at apex. R_{4+5} curved forward and meeting the costa before the apex of the wing. Unpigmented section of M_{1+2} sinuate. First costal sector with short bristles. Second costal sector about as long as the 3rd, slightly shorter than 1st sector. *Abdomen*: Generally black, with white bands at apex of tergites. Female with posterior corners of tergites 2 to 6 with moderately long bristles. Male right clasper (Fig. 9c).

Distribution: Belgian Congo, India, Indo-China, Formosa, Samoa, Micronesia, Hawaii.

This species appears to be widespread in most of the 6 major islands. A ♀ was collected on Laysan Island, 8 April 1923 (D. T. Fullaway). I examined a long series from Hawaii (Waipio Val., and Kohala Mts.), Oahu (Lualualei), and Kauai (Kokee).

Subgenus *Pachytarsella* Richards

8. **Leptocera (*Pachytarsella*) *pachypus* Richards.**

Leptocera (*Limosina*) *pachypus* Richards, 1956 : 135.

This species was originally described from Manoa Valley, Oahu. The types and an additional ♂ collected in leaf litter at Nuuanu Pali, Oahu, 27 January 1967 (J. A. Tenorio), were examined. This species has not been recorded anywhere else other than Hawaii, and so far has been found only on the island of Oahu.

The following description is taken from Richards (1956, pp. 135-36):

Female. Black; top of head and especially mesonotum and scutellum brightly shining; antennae somewhat brownish; tibiae and tarsi dark brown, first two segments of hind tarsi yellowish brown; stalk of halteres brown. Wings hyaline with areas along the longitudinal veins, especially R_{2+3} , considerably clouded. Length 2.3 mm. ...Male. Resembles female except as follows: size about the same; mid femur with two closely placed moderately long bristles near base ventrally, directly obliquely outwards; mid tibiae near apex ventrally with a group of about four long bristles, mid basitarsus rather shorter and stouter, dorsally flattened, a little concave beneath where the small bristles are unusually short and dense; hind trochanter with three or four stout but very short adpressed bristles; hind femur thin on basal quarter, then considerably thickened, curved down where these two parts join, base of femur beneath with one short isolated bristle, distal half beneath also with a row of short bristles, hind tibia somewhat thin at base and thickened towards apex. Abdomen with segments three and four apparently partly sclerotized (more or less as in female), fifth segment shining, very large, longer on left side than on right. Genitalia very large, curved under the abdomen, distal part dull and shagreened, anal split large and elliptical, anteriorly directed, ventral part of genitalia with a group of long dense curved bristles on each side, overlapping one another and also some long bristles on the apical sternites.

Richards (1956) suggested the relationship of this species to the subgenera *Poecilomella* Duda and *Mallochella* Duda, but he pointed out va-

rious characters which made this species distinct from them. At the same time, Richards placed this species "as a rather aberrant member" under the subgenus *Limosina* Macquart. In 1963, Richards erected a new subgenus *Pachytarsella* Richards, 1963, and designated *Leptocera* (*Limosina*) *pachypus* Richards as the type.

Distribution: Hawaii.

Specimens examined: Two ♂, 2 ♀. Islands: Oahu; Manoa Valley, Nuuanu Pali (in leaf litter).

Subgenus *Limosina* Macquart

9. **Leptocera** (**Limosina**) **bifrons** (Stenhammar) (Fig. 1d-i).

Limosina bifrons Stenhammar, 1854: (Richards, 1930 : 302).

Limosina clunipes Verall, 1800: (Richards, *ibid.*).

Limosina puerula Rondani, 1880: (Richards, *ibid.*).

Limosina (*Limosina*) *puerula*, Richards, 1952 : 429.

Limosina bifrons, Hackman, 1965 : 502.

Light brown, sometimes yellowish species. *Head*: Anterior margin of frons yellowish, sometimes red-brown, posterior 2/3rds brown to black. Face shining brown, sinuate in profile. Genae yellow. Antennae with the 1st and 2nd segments yellow to orange; 3rd segment dark brown, hemispherical, with short pale pubescence, less than 1/5th the length of the short pubescent arista. One long vibrissa bristle, jowlar bristles all short. *Thorax*: Humeral callus with 2 bristles, inner 1 directed inward, outer directed backward. One pair of long dorsocentral bristles, about as long as the anterior marginal scutellar bristle. Sternopleura with 2 hair-like bristles. Front legs yellow, middle and hind legs brown, middle coxa black, middle trochanter with a relatively long anterior apical bristle, middle tibia with an anterior apical bristle in addition to the longer ventral apical one. Female hind tibia with a short, but stout, ventral apical bristle. Male hind tibia (Fig. 1e) ventrally with more or less paired rows of comb-like bristles on the apical 1/2, femur with a single row of longer ventral bristles on the basal 1/2. Wings hyaline. First costal sector with relatively long bristles. Second costal sector shorter than 3rd sector. R_{2+3} curved forward at apex. R_{4+5} straight or slightly sinuate. *Abdomen*: Black. Genitalia as in Figs. 1d, f, g. Right clasper of male (Fig. 9d).

Distribution: Europe, Seychelles, S. Africa, Canary Islands, The Azores, Philippine Is., Samoa, Hawaii.

Specimens examined: 100+ ♂, 100+ ♀. Islands: Hawaii; Akaka Falls, Waipio Val., Pauahi. Kauai; Kalalau, Kalalau Lookout, Wainiha Val. Maui; Makamakaole Val., Keanae. Oahu; Kailua (long series reared from cow manure), Woodlawn in Manoa, Foster Gardens, Honolulu. Molokai; Puuohoku Ranch.

10. **Leptocera** (**Limosina**) **brevicostata** var. **ruffrons** Duda (Fig. 2a-f).

Leptocera (*Scotophilella*) *brevicostata* var. *ruffrons* Duda, 1925 : 164, 188.

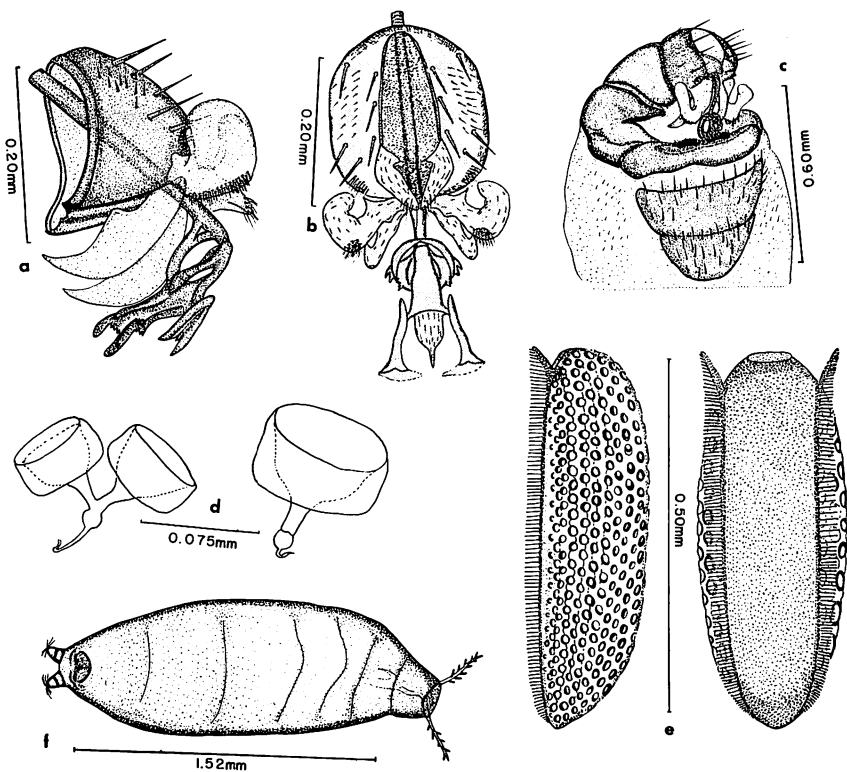


FIG. 2. *Leptocera brevicostata* var. *rufifrons* Duda: a. ♂ genitalia (from left side), b. same (posterior view), c. ♂ posterior (abdominal segments showing genitalia (lateroventral view), d. spermathecae, e. eggs (from right side and dorsal view), f. pupa (ventral view)

Limosina (Limosina) brevicostata var. *rufifrons*, Richards, 1952 : 429.

This variety was originally described from Formosa, New Guinea and Abyssinia. Richards (1963) recorded it from Micronesia (Bonin Is.). The female of this species very closely resembles the female of *L. (L.) brevicostata* Duda. Superficially, the ♂ also is very similar to *brevicostata*, but differ in the following characters. The 5th abdominal sternite is set with 2 separate rows of very closely placed minute bristles near the posterior margin (Fig. 2c). The posterior borders of the 3rd and 4th sternites are longer than the anterior borders, the 4th longer than the 3rd.

Distribution: Formosa, New Guinea, Abyssinia, E. India, Congo, Micronesia, Hawaii.

Specimens examined: 8 ♂, 5 ♀. All from Oahu.

11. *Leptocera (Limosina) pectinata* sp. n. (Fig. 3a-d, 9e.)

This species closely resembles *L. brevicostata* var. *rufifrons* Duda. In Duda (1925, p. 164), it runs to couplet 73, and it agrees with some of the characters of both species, *L. brevicostata* Duda and *L. brevicostata* var. *rufi-*

frons. However, the ♂ genitalia of this species is obviously different from both species. Through the kindness of Dr. H. Schumann of the Zoologisches Museum in Berlin, I was able to examine the type specimen of *L. brevicostata*. The genitalia of the type was not dissected so that comparisons with the present species are made from external evidence only. The type ♂ does not have the comb-like spines along the posterior margin of the 5th abdominal sternite and the anteriorly directed spine on the clasper, both of which are present on this new species. Perhaps there are other differences in genitalia characters, but this can only be ascertained by dissecting the type specimen. The ♀ has been determined based mainly on association with ♂ and on the characteristics of the egg which was obtained from laboratory rearings. The egg of this species is different from the egg of *L. brevicostata* var. *rufifrons* which was also reared in laboratory (see Fig. 2e and 3b).

Male: Except for the setation of the 5th abdominal sternite and the claspers, the ♂ is very similar externally to *L. brevicostata* var. *rufifrons*.

Abdomen: 5th abdominal sternite with comb-like spines directed postero-

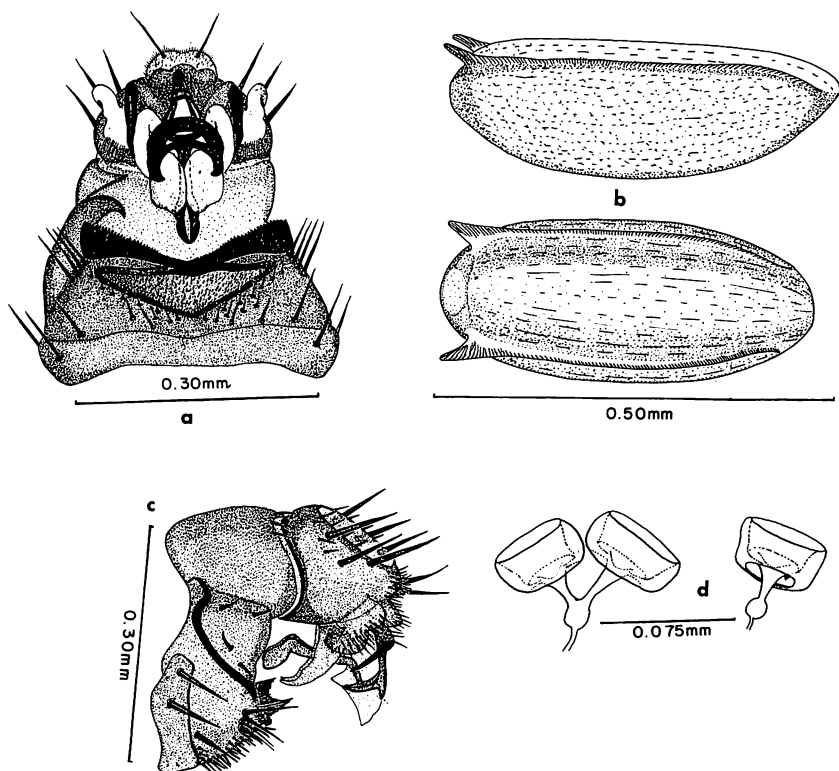


FIG. 3. *Leptocera pectinata* sp. n.: a. ♂ genitalia (ventral view), b. eggs (from left side and dorsal view), c. same as a (from left side), d. spermathecae

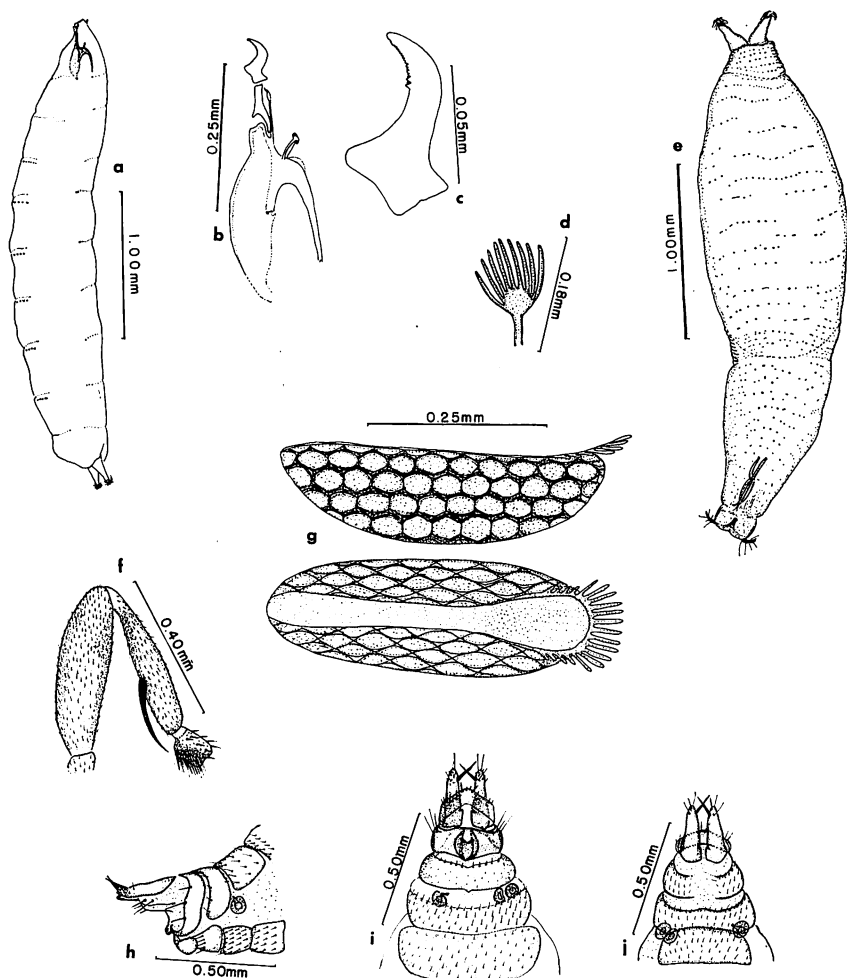


FIG. 4. *Leptocera mirabilis* (Collin): a. last instar larva (from left side), b. cephalopharyngeal skeleton of a, c. mouth hook of a, d. anterior spiracle of a, e. pupa (dorsal view), f. hind leg (anterior view), h. ♀ genitalia (from right side), i. same as h (ventral view), j. same as h (dorsal view)

dorsally along the posterior margin. Spines are longest laterally and gradually decreased in length medially (Fig. 3a, c). Clasper (Fig. 9e) with 1 strong black spine directed anteriorly from lateral view (Fig. 3c) and with a clump of hairs on the lobe lateral to the spine.

Female: Resembles ♂ except for sexual characters. Difficult to distinguish from ♀ of *L. brevicostata* var. *rufifrons*.

Holotype ♂ and allotype ♀: Kailua, Oahu, 22 February 1967 (J. A. Tenorio). Paratypes, 80 ♂ and 54 ♀ from the following localities: all ♀ from the same locality as the allotype; ♂ same data as type; Lualua-

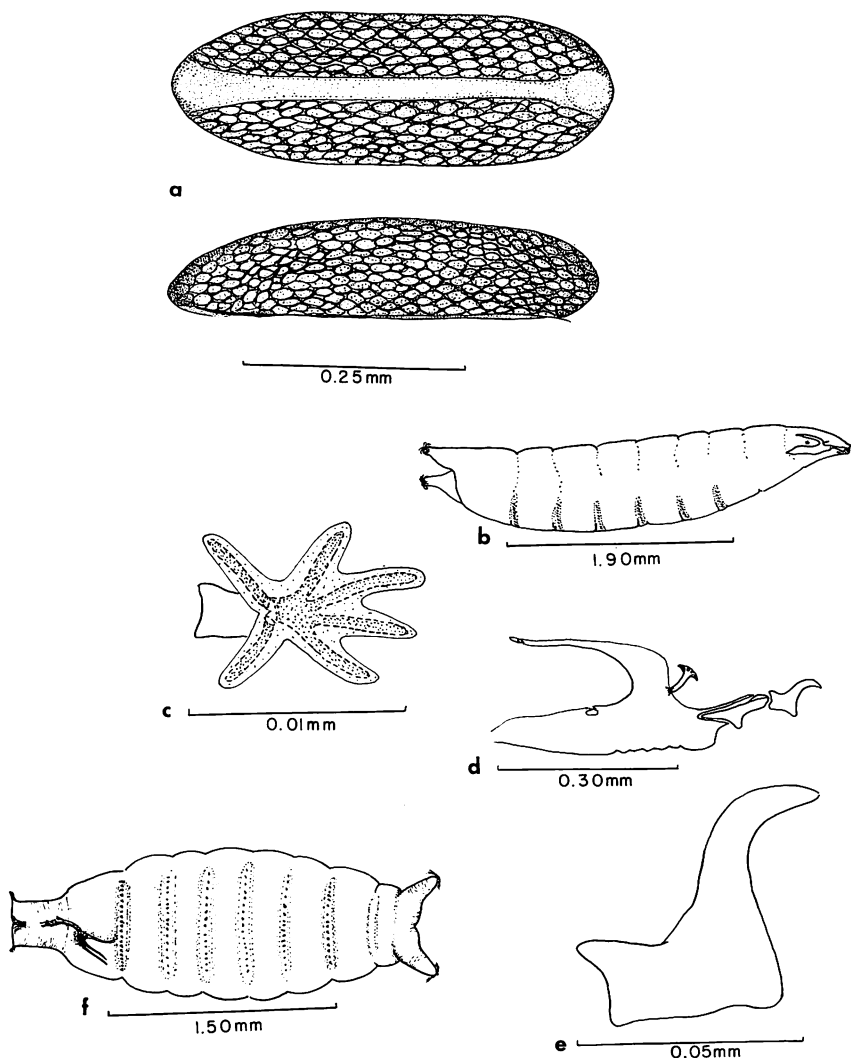


FIG. 5. *Leptocera brachystoma* (Stenhammar): a. eggs (dorsal view and from left side), b. last instar larva (from right side), c. anterior spiracle of b, d. cephalopharyngeal skeleton of b, e. mouth hook of b, f. pupa (ventral view)

lei, Oahu, February, 1952 (D. E. Hardy); Mt. Tantalus, Oahu, April, 1958 (J. W. Beardsley); Waialeale, Oahu, 9 October, 1966 (J. A. Tenorio); Pawaina, Hawaii, 7 July, 1967 (J. A. Tenorio), Honokaa, Hawaii, August, 1959 (D. E. Hardy); Kohala Mts., Hawaii, 29 August, 1966 (J. A. Tenorio); Waipio Val., Hawaii, August, 1952 (D. E. Hardy); Kaiholena Ridge, Hawaii, August, 1952 (W. C. Mitchell); Waikoekoe Forest, Hawaii, 28 August, 1963 (D. E. Hardy); Halawa Val., Molokai, July, 1952 (M. Tama-

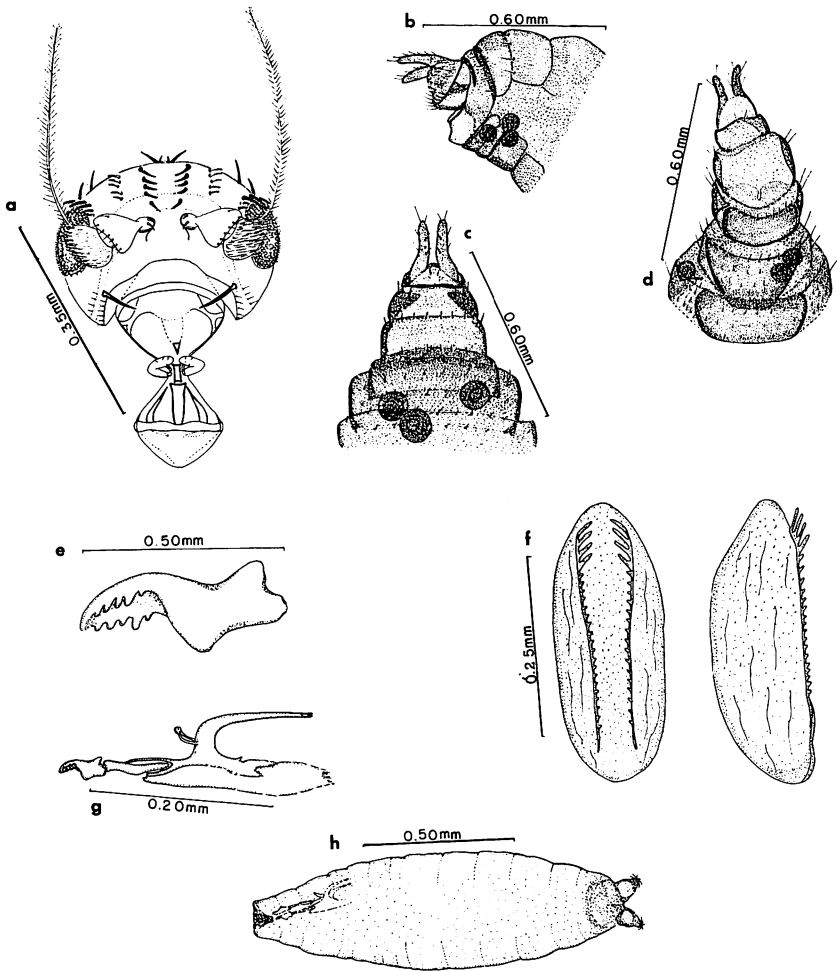


FIG. 6. *Leptocera atomus* (Rondani): a. head (anterior view), b. ♀ genitalia (from right side), c. same as b (dorsal view), d. same as b (ventral view), e. mouth hook of pupa, f. eggs (dorsal view and from left side), g. cephalopharyngeal skeleton of pupa, h. pupa (ventral view).

shiro); Kanae, Maui, July, 1953 (D. E. Hardy); Wainiha Val., Kauai, August, 1953 (D. E. Hardy).

Type, allotype and some paratypes to be deposited in the B. P. Bishop Museum. B. M. No.

12. **Leptocera (Limosina) brevivenosa** Tenorio

Leptocera (Limosina) brevivenosa Tenorio, 1967 : 425.

This species has just recently been described (Proc. Hawaiian Entomol. Soc. 19: 425, 1967). So far, this species has only been reported from

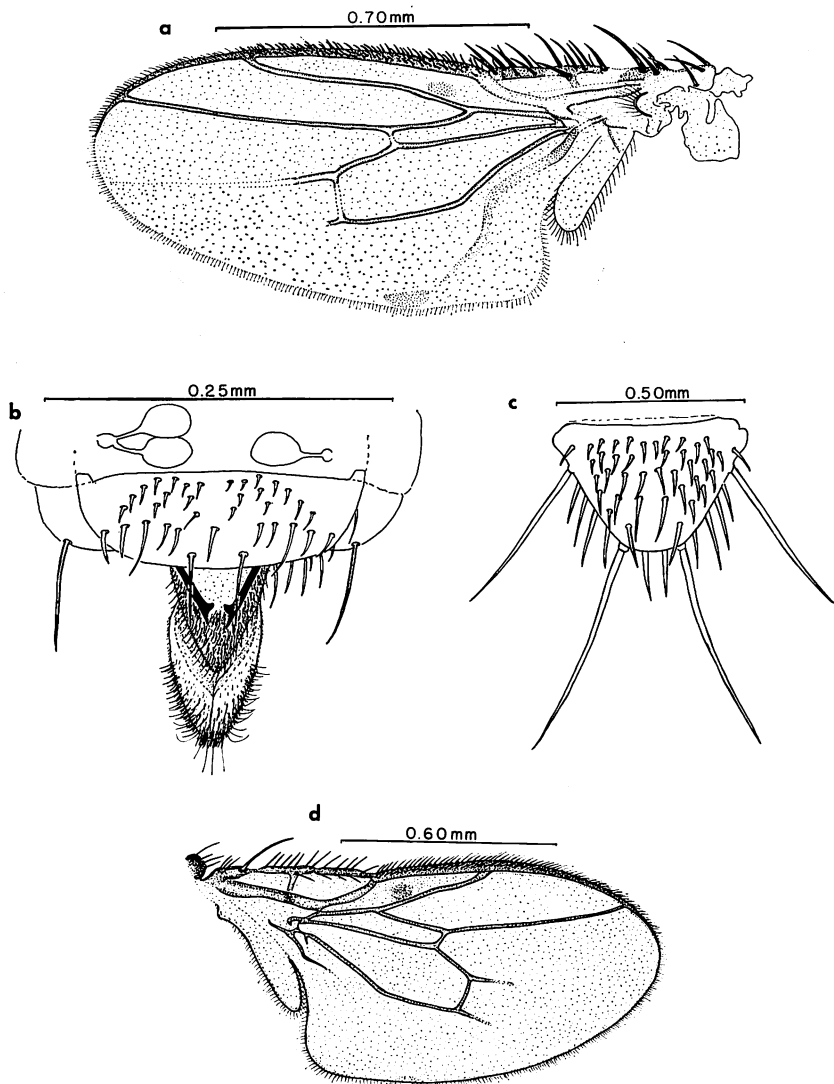


FIG. 7. *Leptocera ferruginata* (Stenhammar): a. left wing (dorsal view), b. ♀ genitalia (ventral view), c. scutellum (dorsal view), *Leptocera hirtula* (Rondani); d. right wing (from top)

the islands of Oahu, Maui and Hawaii. It can be separated easily from other Hawaiian species by the characteristic R_{2+3} . This vein is strongly bent forward and sometimes sinuate apically. Male clasper as in Fig. 10b.

13. ***Leptocera* (*Limosina*) *heteroneura*** (Haliday).

Limosina heteroneura Haliday, 1836.

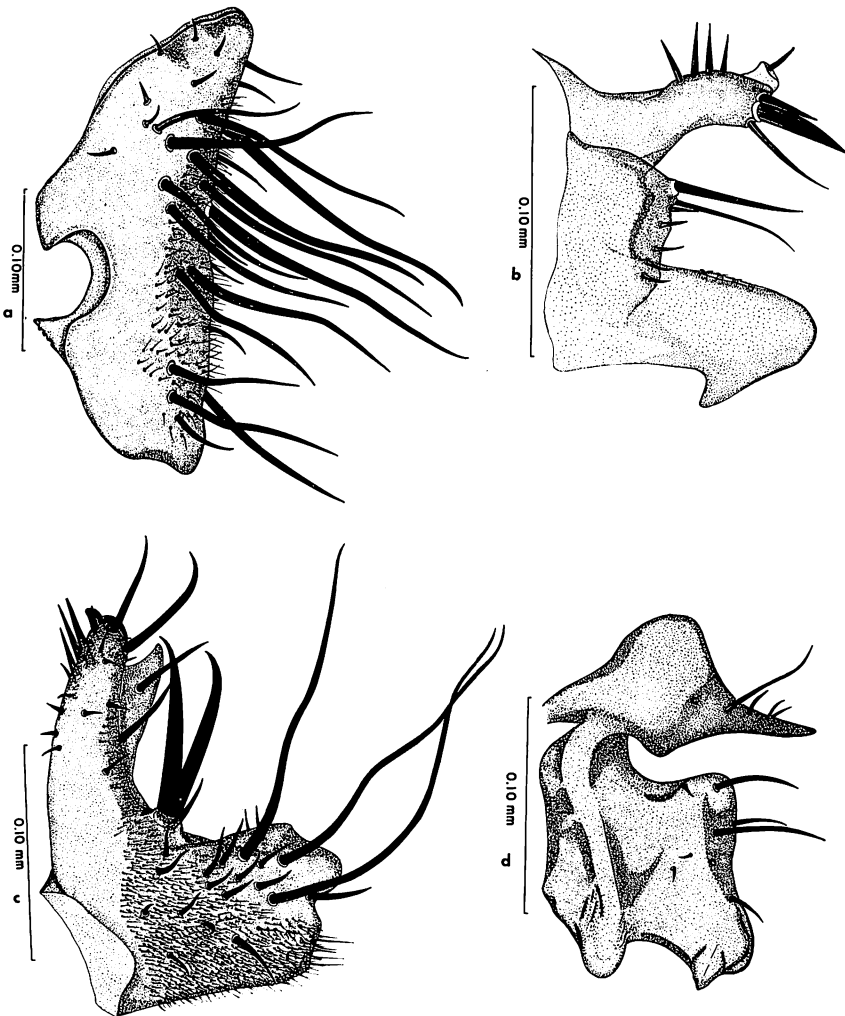


FIG. 8. ♂ right claspers. a. *Copromyza equina*, b. *C. sordida*, c. *Leptocera abdoniseta*, d. *L. downesi*

This species is similar to *L. brachystoma* (Stenhammar) and *L. bifrons* (Stenhammar). It differs from them in that the *r-m* and *m* crossveins of this species are situated very close together, the distance between them less than $1/2$ the length of the *m* crossvein. This species was originally described from the United Kingdom.

Generally brown to black species, legs yellowish. Head with frons shining brown to black. Thorax with 2 dorsocentral bristles, both behind the suture, the anterior 1 less than $1/2$ the length of the posterior one, which is about $1/2$ as long as the anterior pair of marginal scutellar bristles.

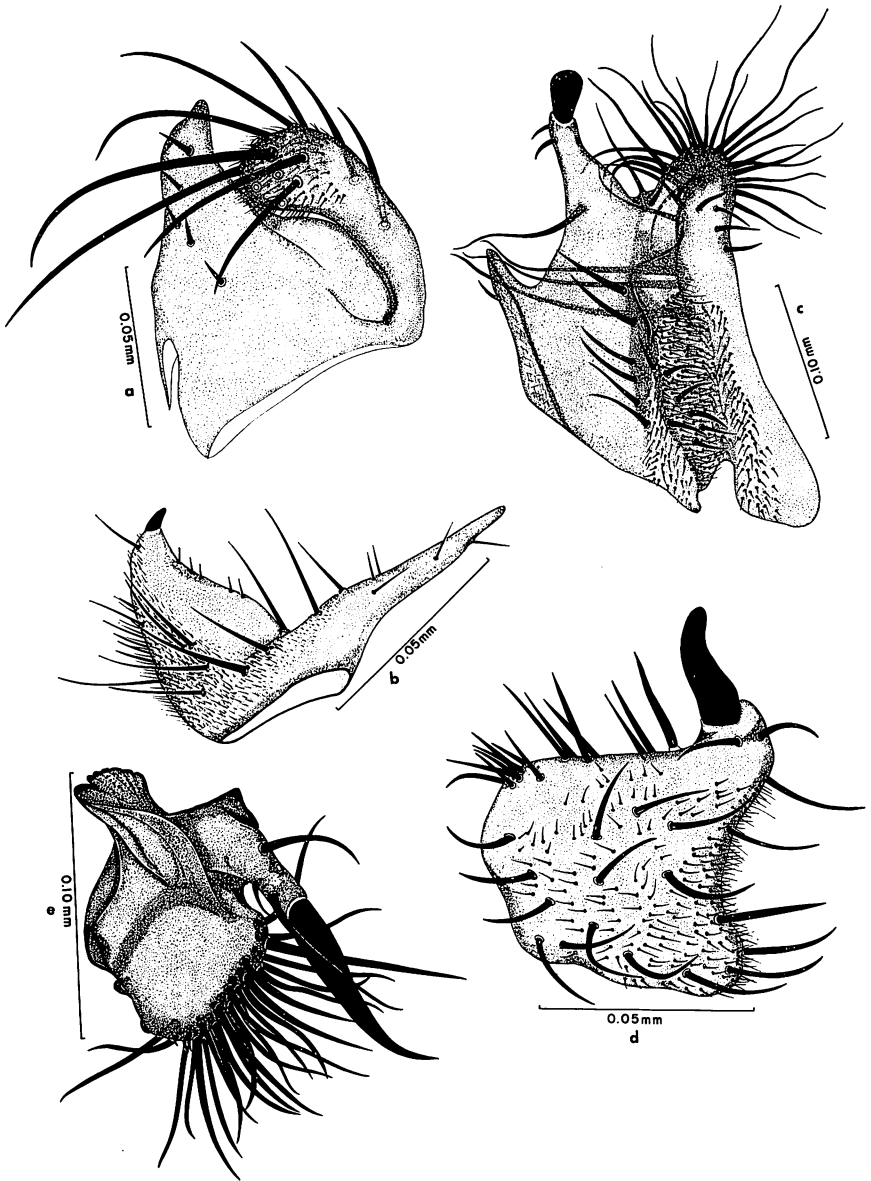


FIG. 9. ♂ right claspers: a. *L. aequalis*, b. *L. brachystoma*, c. *L. punctipennis*, d. *L. bifrons*, e. *L. pectiniata* sp. n.

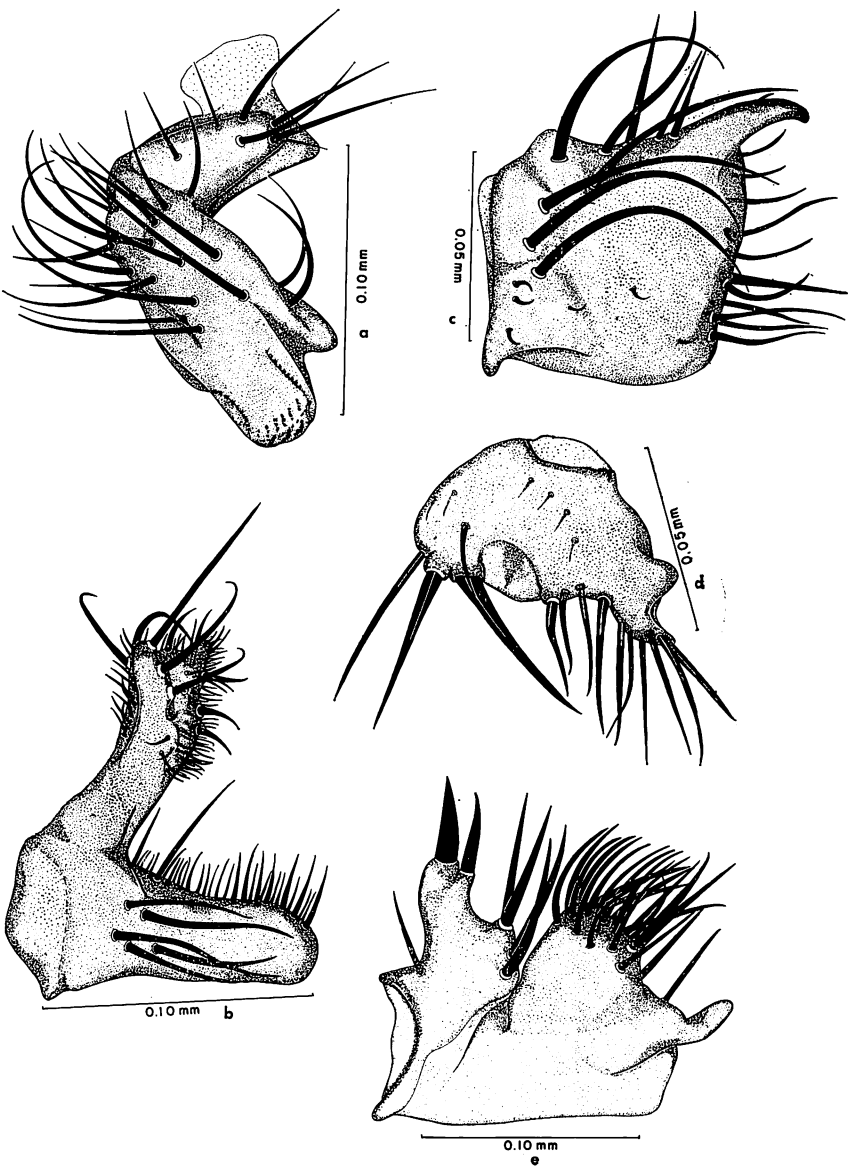


FIG. 10. ♂ right claspers: a. *L. brevicostata* var *rufifrons*, b. *L. brevivenosa*, c. *L. heteroneura*, d. *L. mirabilis*, e. *L. empirica*

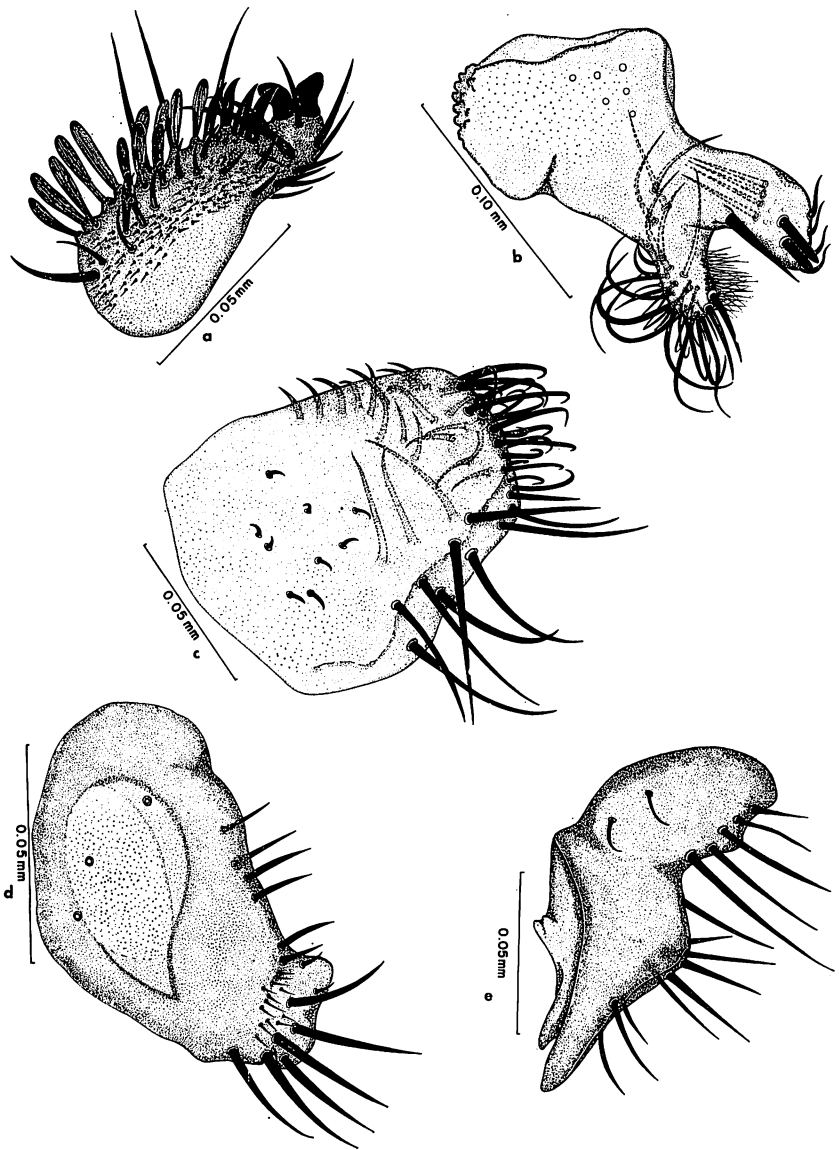


FIG. 11. ♂ right claspers: a. *L. atomus*, b. *L. acutangula*, c. *L. ferruginata*, d. *L. hirtula*, e. *L. vagans*

Wings hyaline. R_{2+3} strongly bent forward at apex. R_{4+5} bent forward at level of $r-m$ crossvein and meeting the costa before the wing apex. Costa overpassing R_{4+5} by a distance about equal to, or less than, the length of m crossvein. Crossveins $r-m$ and m are separated by a distance $1/2$ or less than $1/2$ the length of m . Middle basitarsus more than $1/2$ as long as middle tibia. Body length approximately equal to wing length, 1.2 mm. Male right clasper as in Fig. 10c.

Distribution: United Kingdom, Europe, N. America, Formosa, Africa, Hawaii.

Specimens examined: Five ♂, six ♀. Islands: Hawaii; Kamuela. Oahu; Manoa, Moanalua, Waipio Peninsula, Honolulu, Kam. O. H. in Kalihi, John Rodgers light traps. Molokai; Kalae.

14. **Leptocera** (**Limosina**) **mirabilis** (Collin) (Fig. 4a-j).

Limosina mirabilis Collin, 1902 : 59.

Leptocera (*Scotophilella*) *mirabilis*, Spuler, 1925c : 76.

This species was originally described from England.

Black, usually shining, species. Thorax with only a pair of dorsocentral bristles. The apical margin of the scutellum more or less parallel to the scutellar suture. Sternopleura with 1 bristle. Hind tibia ventrally with a long curved bristle arising slightly beyond the middle and extending beyond the apex of the tibia. Wing hyaline. Second costal sector as long as, or shorter than, the 3rd sector. R_{2+3} bent forward at apex. R_{4+5} slightly curved forward. Costa overpassing R_{4+5} only slightly. Alula narrower and shorter than the subcostal cell. Male right clasper as in Fig. 10d.

Distribution: England, Europe, N. America, Hawaii.

Specimens examined: A long series of both ♂ and ♀ from Kailua, Oahu. Island: Hawaii; Paauilo, Kohala Mts., Keanakolu, Saddle Road, 29 mi. Olaa. Kauai; Kalalau. Maui; Kula Pipeline, Olinda. Oahu; Kailua. Molokai; Kalaupapa Lookout.

15. **Leptocera** (**Limosina**) **empirica** (Hutton).

Limosina empirica Hutton, 1901 : 94.

Limosina pectinifera Villeneuve, 1917.

Limosina cadaverina Duda, 1918 : 130.

This species was originally described from New Zealand.

Of the Hawaiian Sphaeroceridae, this species resembles most closely *L. aequalis* (Grimshaw). It differs in the chaetotaxy of the legs of both ♂ and ♀. Middle tibia with an apical ventral bristle, middle basitarsus lacking the long ventral bristle near the base, and hind tibia with a preapical dorsal bristle. Middle leg of ♂ with a group or tuft of ventral bristles at basal portion of femur and apical portion of tibia.

Male: Predominantly black. *Head*: Frons, face, and genae dull black with a reddish tinge especially along the anterior margin of the frons.

Eyes relatively small, longest diameter less than $1/2$ the height of the head. Antennae black, 3rd segment kidney-shaped and higher than long, arista short pubescent and about 6 times as long as the 3rd segment. Face carinate, concave on sides of carina below the antennae, and conspicuously protruding in front of the eye in profile. Vibrissa angle with 2 bristles, the inner 1 about twice as long as the outer; 1 of the jowlar bristles directed upward and equal to more than $1/2$ the length of the longest vibrissa. Gena dull below the eyes, postgena shining. *Thorax*: Humeral callus with a strong backwardly directed bristle and a minute one directed inward. Four pairs of dorsocentral bristles, the 2 anterior pairs weak. The prescutellar acrostichals about $1/2$ as long as the longest pair of dorsocentrals. Sternopleura with a strong bristle, and some microscopic hairs anterior to this bristle. Front femur dorsally with a row of widely spaced bristles, a posteroventral bristle at base, and 4 to 5 posteroventral bristles in a row at about apical half; tibia dorsally with a bristle at apical $1/3$. Middle femur ventrally with a tuft of bristles at the base; tibia bent ventrally at about apical $1/3$ and with a tuft of ventral bristles at the apex, in addition to the ventral apical bristle. Wing with the first costal sector having short bristles. The first 3 costal sectors are about equal in length. R_{2+3} curved forward at apex. R_{4+5} straight and meeting the end of the costa slightly before the apex of wing. Body length about 2.3 mm, wing about 2.1 mm. Male right clasper (Fig. 10e).

Female: Matching the description of the ♂ except for sexual differences. It lacks the tuft of ventral bristles at the base of the middle femur and at the apical $1/3$ of the middle tibia. Middle tibia with a middle ventral bristle.

Distribution: Europe, Iceland, Canada, New Zealand, Campbell Is., Falkland Is., Juan Fernandez, England, Hawaii.

Specimens examined: 9 ♂ and 6 ♀ from Haleakala, Maui, February, 1965 (R. Hansen).

Subgenus *Trachyopella* Duda

16. *Leptocera* (*Trachyopella*) *hardyi* Tenorio

Leptocera (*Trachyopella*) *hardyi* Tenorio, 1967 : 427.

For detailed description of this species, see Proc. Hawaiian Entomol. Soc. **19**: 427, 1967. This species has been reported from only 3 of the major Hawaiian Islands; Hawaii, Lanai, and Oahu.

I have seen 1 unidentified specimen from Micronesia (in B. P. Bishop Museum, Honolulu) which I believe belongs in this species. I have, therefore, tentatively included Micronesia in the distribution of this species.

This species is very small, approximately 1.2 mm in length. It is very similar to *Leptocera obliqua* Richards, from which it can be separated by the wing venation (R_{2+3} arched and running very close to the costa for a short distance).

17. **Leptocera (Trachyopella) atomus** (Rondani) (Fig. 6a-h).*Elachisoma atomus* Rondani, 1880 : 19.*Limosina (Trachyopella) atoma*, Duda, 1918 : 195.*Leptocera (Trachyopella) atoma*, Richards, 1930 : 131.

"The specific name was originally a masculine noun and a change of genera does not alter the gender" (Richards, 1963, p. 129).

This species was originally described from Italy.

Head bristles are relatively short. Antennae divergent and directed outward, 3rd segment and arista relatively long pubescent. Eyes hairy. Wing with second costal sector and R_{2+3} half, or less than $1/2$, as long as the 3rd sector. Costa overpassing R_{4+5} for a considerable distance, this distance about equal to the length of R_{2+3} . Very small species. Right clasper of ♂ as in Fig. 11a.

Distribution: Europe, England, Canary Is., Madeira, Belgian Congo, Micronesia (Mariana Is.), Hawaii.

Specimens examined: 22 ♂, 37 ♀, and a long series from Kailua, Oahu. Islands: Lanai; Lanaihole. Oahu; Kailua, Hanauma Bay, Ewa.

18. **Leptocera (Trachyopella) obliqua** Richards.*Leptocera (Trachyopella) obliqua* Richards, 1963 : 129.

This species was first described from Micronesia (Ponape) collected in a light trap. Its relationship with the new Hawaiian species has already been mentioned (Proc. Hawaiian Entomol. Soc. **19**: 427. 1967)

Antennae widely separated and directed outward. Face concave below the antennae. Thorax with a pair of dorsocentral bristles and 3 or more irregular rows of acrostichals between them. Wing with R_{2+3} removed from the costa, but running almost parallel to it and bent forward at the apex; 2nd costal sector as long as, or longer than, the 3rd sector.

Distribution: Micronesia (Caroline Is., S. Mariana Is.), Hawaii.

Specimens examined: 4 ♂ and 3 ♀. Islands: Oahu; Kailua, Manoa Valley, U. H. (light trap).

Subgenus *Coproica* Rondani19. **Leptocera (Coproica) acutangula** (Zetterstedt).*Limosina acutangula* Zetterstedt, 1847 : 2499.*Limosina opacula* Stenhammar, 1854: (Richards, 1930).*Leptocera (Heteroptera) pusilla* Meigen, 1830, of Richards, 1930.

This species was first described from Sweden.

Predominantly black species. Face, genae, and front coxae rather brown in color. Antennae with tinge of red on the ventral side, the apex of the 3rd segment and the arista are black. Thorax with 2 humeral bristles, about equal in length, the inner inwardly directed and the outer backwardly directed. Sternopleura with 2 weak bristles, about $1/2$ as long as

the longest humeral bristle. Wings milky. The base of costa with 2 relatively long bristles. First costal sector with short bristles, 2nd sector distinctly longer than the 3rd sector. Costa overpassing R_{4+5} , this portion of costa less than $1/2$ the length of basal section of R_{4+5} . Costa ending nearly at apex of wing. Last section of R_{4+5} straight. Male with vein M_{1+2} bent backward and forming a more or less straight line with the inclining m crossvein; margin of wing opposite discal cell with a row of long bristles curving forward beneath the wing; front basitarsus club-shaped; hind basitarsus ventrally with apical projection. Male right clasper (Fig. 11b).

Distribution: Europe, England, Madeira, Belgian Congo, N. America, Hawaii.

Specimens examined: Long series of both males and females reared from horse manure in Kailua, Oahu, 25 November, 1966 (J. A. Tenorio).

20. **Leptocera (Coproica) ferruginata** (Stenhammar) (Fig. 7a-c).

Limosina ferruginata Stenhammar, 1854 : 397.

Borborus illotus Williston, 1896 (Richards, 1930).

Leptocera (Coproica) ferruginata, Spuler, 1925a : 123.

Leptocera (Heteroptera) ferruginata, Richards, 1930 : 307.

Limosina (Coproica) ferruginata, Richards, 1952 : 431.

Coproica ferruginata, Hackman, 1965 : 502.

This species was originally described from Sweden.

Head predominantly dark brown. Thorax predominantly reddish-brown. Face concave below the antennae. Mesonotum usually with reddish vittae on the dorsocentral line. Legs generally dark brown. Sternopleura with 3, sometimes 4, moderately long bristles. Hind tibia with a preapical dorsal hair-like bristle. First costal sector with long bristles (Fig. 7a). Second costal sector almost twice as long as 3rd sector. Costa overpassing R_{4+5} , this portion of costa less than $1/2$ the length of the basal section of R_{4+5} . Abdomen black. Female posterior abdominal segments as in fig. 7b. Male right clasper (Fig. 11c).

Distribution: Europe, England, Africa, N. and S. America, N. Atlantic Islands, Micronesia (Guam), Samoa, New Zealand, Hawaii.

Specimens examined: 27 ♀, 23 ♂. Islands: Oahu; Wailupe, Honolulu, Ft. Shafter, U. H. Dairy Farm, Moanalua, Waikiki, U. H. Campus, Aiea, Waiialae, Kailua.

21. **Leptocera (Coproica) hirtula** (Rondani) (Fig. 7d).

Limosina hirtula Rondani, 1880 : 40.

Limosina exigua Adams, 1904 : 454 (preoccu. Rondani, 1880).

Leptocera (Coproica) hirtula, Duda, 1925.

Leptocera (Coproica) exiguella Spuler, 1925a : 123 (n. name for *exigua* Adams).

Leptocera (Heteroptera) hirtula, Richards, 1930 : 308.

Limosina (Coproica) hirtula, Richards, 1952 : 431.

This species was first described from Italy. It has since been recorded from many places and is considered a cosmopolitan species.

Predominantly black species with the anterior margin of frons orange to red-brown. Humeral callus with 3 bristles, the longest 1 directed posteriorly. First costal sector of wing with short bristles. Second costal sector more or less shorter than the 3rd (Fig. 7d). Costa overpassing R_{4+5} , this portion of costa more than $1/2$ as long as basal section of R_{4+5} . Veins R_{2+3} and R_{4+5} distinctly curved forward. Middle tibia with a preapical and a shorter apical bristle. Middle basitarsus with a ventral bristle near the base and a longer anteroventral bristle slightly beyond the middle. Right clasper of male (Fig. 11d).

Distribution: Widespread in N. America, Bermuda, cosmopolitan, Hawaii.

Specimens examined: 98 ♂, 206 ♀. Islands: Hawaii; Olan. Kauai; Wailua, Kalalau. Oahu; widespread. Molokai; Kinalu, Kanoa. Laysan Island, Nihoa Is., French Frigate Shoals, Necker Is., Trig Is., Midway Is.

22. *Leptocera* (*Coproica*) *vagans* (Haliday).

Borborus vagans Haliday, 1833 : 178.

Limosina albipennis Rondani, 1880 : 41.

Leptocera (*Coproica*) *vagans*, Spuler, 1925a : 123.

Leptocera (*Heteroptera*) *vagans*, Richards, 1930 : 307.

Coproica vagans, Hackman, 1965 : 502.

This species was originally described from Ireland. It seems to be widely distributed and Richards (1965) considers it cosmopolitan.

Predominantly dark or black species. Frons black, with areas at base of frontal bristles usually brown or lighter than most of the frons. Antennae and face red-brown. Thorax with 4 humeral bristles, 2 are minute. Two sternopleural bristles about equally long and widely spaced. Wing with a pair of rather long bristles at the base of the costa. First costal sector with short bristles. Second costal sector distinctly longer than the 3rd. Costa overpassing R_{4+5} , this section of costa $1/2$ or less than $1/2$ the length of basal section of R_{4+5} .

This species closely resembles *L. hirtula* (Rond.). It differs in that the 2nd costal sector is distinctly longer than 3rd sector, frons completely dark brown or black, slightly larger species, and with milky wings. Male right clasper (Fig. 11e).

Distribution: Europe, England, Canary Is., Africa, N. and S. America, Formosa, Micronesia and Hawaii.

Specimens examined: 83 ♂, 92 ♀. Islands: Oahu; Waialeale Livestock Research Farm (U. H.), Honolulu, Kahaluu.

BIOLOGY

The adult flies of the family Sphaeroceridae have constantly been associated with decaying organic matter of a diverse nature. Because of

this association, the larval stages have been presumed to be basically scavengers. Most of the biological information on the Sphaeroceridae has been compiled by Richards (1930). From his most comprehensive studies, the breeding media of this family have indeed proved quite varied including horse manure, cow manure, human excrement, urine, dog dung, fungi, dead animals, ant and wasp nests, and decaying plants of various sorts. Hammer (1941), in his studies on the biology and ecology of flies associated with pasturing cattle, found 19 species of Sphaeroceridae on cattle and cattle droppings. Laurence (1954, 1955) also made ecological and biological studies of some Sphaeroceridae in cow manure. Although the above mentioned authors made some references to several species of Sphaeroceridae which also occur in Hawaii, their studies were only in relation to the particular localities in which they worked.

At present, there is no information on the biology of the Hawaiian Sphaeroceridae *per se*. Available literature deals essentially with the recordings of species or taxonomic studies. For this reason, an attempt has been made here to gather information which might shed some light on the biologies of the species that occur in Hawaii.

The notes presented below were obtained from collection labels and rearings which were carried out in conjunction with the taxonomic work in this paper. The biological data are by no means complete, but it is hoped that their inclusion here will serve as a supplement and a reference for future biological studies.

HABITAT RECORDS

The word habitat is used here loosely to include any place from which individuals, or groups of flies, have been collected.

Following are collection records which are indicative of the habitats of Hawaiian species. These records are primarily based on labels which are assigned to the specimens in collections. The collections in the B. P. Bishop Museum and in the University of Hawaii were examined for this purpose.

The habitats are listed in detail here, as it is felt that they may be important items of reference for future biological studies.

1. *Copromyza equina* Fallén.

- a. Horse manure, Kohala Mts., Hawaii, 29 August, 1966 (J. A. Tenorio); ♂ and ♀.
- b. Banana bait trap, Kokee, Kauai, 27 July, 1959 (J. W. Beardsley); ♂.

2. *Copromyza sordida* (Zetterstedt).

- a. Cattle excreta, Honolulu, Oahu, December, 1909 (Terry); 4 ♂, 3 ♀.
- b. Horse manure, Kailua, Oahu, 13 November, 1966 (J. A. Tenorio). A large number was observed on horse manure in

the Kohala Mts.

- c. Light trap, U. H., Oahu, 15 December, 1963 (J. W. Beardsley, Jr.); ♂.
3. *Leptocera abdominiseta* Duda.
 - a. Light traps or at lights, from various localities on Oahu covering the period between 1951 to 1960 (H. Toba, D. E. Hardy, J. Rosa, J. W. Beardsley, Jr.); 26 ♂, 31 ♀. Waipio Valley, Hawaii, January, 1956 (J. W. Beardsley, Jr.); 2 ♀.
 - b. Bait trap, Honolulu, Oahu, April, 1951 (D. E. Hardy); ♂ and ♀.
 - c. Cow manure, Waialeale, Oahu, 9 October, 1966 (J. A. Tenorio); 3 ♂, 4 ♀.
 - d. Leaf litter in woods, Nuuanu Pali, Oahu, 25 February, 1967 (J. A. Tenorio); 9 ♂, 6 ♀.
4. *Leptocera downesi* Richards.
 - a. On weeds, Ala Wai Canal, Oahu, 16 April, 1950 (M. S. Adachi); ♂ and ♀.
 - b. Light traps and at lights, U. H. Campus, Oahu, April, 1960 (H. Toba); Ewa, Oahu, January 1952 (J. Rosa); John Rodgers Light Traps, Oahu, May 1958 (E. J. Ford); Public Health light traps, Kawaiiloa, Kaneohe Fire St., Sunset Beach, Oahu, March 1966; 25 ♂, 22 ♀.
5. *Leptocera aequalis* (Grimshaw).
 - a. About water pools, Kamokuiki Val., Oahu, 13 April, 1933 (E. H. Bryan, Jr.); 17 ♂, 14 ♀.
 - b. On window, Kainalu, Molokai, 13 January, 1927 (E. H. Bryan, Jr.); ♂.
 - c. On ginger leaves, Manoa Falls, Oahu, April 1958 (D. E. Hardy); 2 ♀. (Probably resting on leaves.)
6. *Leptocera brachystoma* (Stenhammar).
 - a. Seaweed, Lisiansky Is., 18 May, 1923 (C. Grant); Kailua, Oahu, 13 November, 1966 (J. A. Tenorio); 10 ♂ and 5 ♀ from Lisiansky Is., a long series of both sexes from Kailua.
 - b. At light, Honolulu (Quarantine Is.), Oahu, 25 March, 1923 (S. C. Ball); ♂.
7. *Leptocera punctipennis* (Wiedemann).
 - a. Light traps, Wailua, Kauai, December, 1956 (C. A. Isenberg); Public Health light traps, Oahu, 15 November, 1965 (J. W. Beardsley, Jr.); a ♂ each from Kauai and Oahu.
 - b. On window, U. H. Farm, Oahu, 10 December, 1926 (E. H. Bryan, Jr.); ♂.
 - c. Poultry manure, U. H. Campus, Oahu, 26 May, 1946 (Y. Tanada); ♂ and 2 ♀.

- d. Pig manure, Halawa, Oahu, 17 December, 1922 (O. H. Swezey); 6 ♂, 6 ♀.
- e. Cow manure, Kohala Mts., Hawaii, 29 August, 1966 (J. A. Tenorio); Kailua, Oahu, 13 November, 1966 (J. A. Tenorio); long series of both sexes from Kohala Mts., and about 27 ♂ and ♀ from Kailua (many more were observed on or about the same manure piles).
- 8. *Leptocera pachypus* Richards.
 - a. Leaf litter (in woods), Nuuanu Pali, Oahu, 27 January, 1967 (J. A. Tenorio); ♂.
- 9. *Leptocera bifrons* (Stenhammar).
 - a. At window, U. H. Farm (Honolulu), Oahu, 10 December, 1926 (E. H. Bryan, Jr.); Honolulu, Oahu, February, 1950 (D. E. Hardy); ♂ from each.
 - b. Hen manure, Oahu, March, 1916 (J. F. Illingworth); specimen damaged, probably ♂.
 - c. Cow manure, Kailua, Oahu, 13 November, 1966 (J. A. Tenorio); long series of both ♂ and ♀.
- 10. *Leptocera brevicostata* var. *rufifrons* Duda.
 - a. Rotten pepper, Honolulu, Oahu, April, 1927 (E. H. Bryan, Jr.).
 - b. On window, Oahu, April, 1951 (D. E. Hardy); ♀.
 - c. Cow manure, U. H. Campus, Oahu, 5 March, 1967 (J. A. Tenorio); 5 ♂, 7 ♀.
- 11. *Leptocera brevicostata* Duda.
 - a. Cow manure, Kailua, Oahu, 28 February, 1967 (J. A. Tenorio); a long series of ♂ and ♀.
- 12. *Leptocera brevivenosa* Tenorio.
 - a. Leaf litter (in woods), Nuuanu Pali, Oahu, 27 January, 1967 (J. A. Tenorio); 15 ♂, 11 ♀.
 - b. Dung (probably dog), Nuuanu Pali, Oahu, 27 January, 1967 (J. A. Tenorio).
- 13. *Leptocera heteroneura* (Haliday).
 - a. Light trap, John Rodgers Light Trap, Oahu, May 1958 (E. J. Ford); ♂.
- 14. *Leptocera mirabilis* (Collin).
 - a. Cow manure, Kailua, Oahu, 13 November, 1966 (J. A. Tenorio); a long series of both sexes.
- 15. *Leptocera pectinifera* (Villeneuve).
 - a. Haleakala, Maui, February 1965 (R. Hansen); 9 ♂, 6 ♀.
- 16. *Leptocera arcuata* Tenorio.
 - a. On grass, Kamuela, Hawaii, 27 June, 1963 (D. E. Hardy); ♂ and ♀.
 - b. Horse manure, Kailua, Oahu, 22 February, 1967 (J. A. Tenorio).

rio); ♂.

17. *Leptocera atomus* (Rondani).
 - a. Light trap, Waipio, Oahu, May 1956 (J. W. Beardsley, Jr.); ♀.
 - b. Hen manure, Honolulu, Oahu, no date (J. R. Illingworth), ♀.
 - c. Horse manure, Kailua, Oahu, 13 November 1966 (J. A. Tenorio); a long series of both ♂ and ♀.
18. *Leptocera obliqua* Richards.
 - a. Light traps and at lights, Waipio, Oahu, May 1956 (J. W. Beardsley, Jr.); Manoa Val., Oahu, 14 March 1939 (E. H. Bryan, Jr.); ♂ and ♀.
 - b. Horse manure, Kailua, Oahu, 13 November, 1966 (J. A. Tenorio); ♂ and 2 ♀.
19. *Leptocera acutangula* (Zetterstedt).
 - a. Horse manure, Kailua, Oahu, 13 November, 1966 (J. A. Tenorio); a long series of both sexes.
20. *Leptocera ferruginata* (Stenhammar).
 - a. Manure (dairy), Oahu, June 1914 (J. F. Illingworth); Moanalua, Oahu, 20 October, 1922; Ft. Shafter, Oahu, 19 October, 1922; U. H. Campus, Oahu, 18 October, 1922 (J. F. Illingworth); 20 ♂, 19 ♀.
 - b. Cow manure, Kailua, Oahu, 13 November, 1966; Waialeale, Oahu, 9 October, 1966 (J. A. Tenorio); 8 ♂, 11 ♀.
21. *Leptocera hirtula* (Rondani).
 - a. Light traps and at lights, Waipio, Oahu, May 1956 (J. W. Beardsley, Jr.); Honolulu, Oahu, April 1951 (D. E. Hardy); Wailua, Kauai, December 1956 (C. A. Isenberg); 2 ♂ and 3 ♀.
 - b. On windows, Expt. St. A. H. P. C., November 1928 (no collector); Honolulu, Oahu, October 1953 (D. E. Hardy); H. S. P. A. Expt. St., Oahu, 6 December, 1938 (F. X. Williams); 3 ♂.
 - c. Hen or poultry manure, Honolulu, Oahu, no date (J. F. Illingworth); U. H. Campus, Oahu, 24 May, 1946 (Y. Tanada); 3 ♂, 5 ♀.
 - d. Cow manure, Honolulu, Oahu, December 1909 (no collector); Waialeale, Oahu, 9 October, 1966 (J. A. Tenorio); 13 ♂, 14 ♀.
 - e. Dead snails, Honolulu, Oahu, April 1951 (D. E. Hardy); 2 ♂ and 2 ♀.
 - f. On plants: *Ipomoea pes-caprae*, Kanoa, Molokai, 27 April, 1931 (O. H. Swezey), ♂; *Chenopodium oahuense*, *Portulaca lutea*. Necker Is., 26 September, 1964 (J. W. Beardsley, Jr.),

♂ and ♀. These flies were probably just resting on the plants when captured.

- g. Bait traps, Honolulu, Oahu, April and November 1951, November 1952 (D. E. Hardy); 49 ♂, 132 ♀.

22. *Leptocera vagans* (Haliday).

- a. Light trap, Kahaluu, Oahu, November 1955 (D. E. Hardy); ♂ and 2 ♀.
b. Cow manure, Waialeale, Oahu, 9 October, 1966 (J. A. Tenorio); 79 ♂, 89 ♀.

BREEDING RECORDS AND NOTES

In rearing out the species below, natural substrate brought into the laboratory was utilized. In most cases this was cow manure. No attempt was made to determine the larval stadia, but the duration between egg, larval, pupal and adult stages was recorded as accurately as possible. In the following list, I have also included species which were reared out from the natural substrate, but for which no immature stages were collected.

All of the species for which rearings were carried out have a short life cycle, on the average, about 12 days from egg to adult.

Examinations of the eggs recovered in the rearings seem to indicate that the ornamentations on the eggs, in the form of reticulations and projections or processes, are distinct for each species. While the larval and pupal characters are not as striking as in the eggs, some do have distinct species characters as manifested by differences in mouth hooks, spiracles, and body hooks.

All of the 6 species listed below are commonly found in manure, except for 1 species which appears to be restricted to seaweed.

Leptocera brachystoma (Stenhammar): This species was found in seaweed at the high tide line. It seems to occur in relatively small numbers, but breeds prolifically in the laboratory. In the seaweed from which this species was collected were found other flies, such as Ephydriidae, Tethinidae, Dolichopodidae, and Empidae. In nature, *L. brachystoma* is evidently preyed upon by a species of Empidae, *Chersodromia hawaiiensis* Melander, as it was observed in the laboratory to catch and feed upon the sphaerocerid. However, *C. hawaiiensis* is apparently not specific on *L. brachystoma* as it was also observed to attack and make a meal out of a Tethinidae present in the breeding media.

The complete life cycle, from egg to adult, of this species takes about 11 days. The eggs require from 8 to 24 hours to hatch; the larva develops completely in 5 to 7 days; and the pupa takes approximately 4 days.

The egg chorion, except for the flat (dorsal) surface, is reticulated (Fig. 5 a); it is otherwise lacking the striking ornamentation of some of the other species. The larva (Fig. 5 b) and the pupa (Fig. 5 f), on the other hand, are quite characteristic. The body hooks are distinctly vis-

ible; the posterior pair of spiracles is elongated (Fig. 5 f) and the anterior pair is set with finger-like processes (Fig. 5 c). Mouth hooks as in Figs. 5 d, e.

Sizes of the immature stages are as follows: eggs, 0.48 mm long, 0.08 mm wide; larvae (prepupae), 2.80 mm long, 0.70 mm wide; pupae, 2.40 mm long, 0.85 mm wide.

Leptocera bifrons (Stenhammar): This species has been found in leaf litter as well as in cow and horse manure. In November, 1966, it was observed in large numbers on cow manure and in less abundance on horse manure. This species was bred in cow manure in the laboratory. Eggs hatched in 12 to 24 hours; complete development of the larva took from 4 to 6 days; the pupal stage lasted from 3 to 5 days. Complete life cycle, egg to adult, required from 8 to 12 days.

Sizes of immature stages: egg, 0.48 mm long, 0.33 mm wide; pupa, 1.86 mm long, 0.59 mm wide.

Leptocera brevicostata var. *rufifrons* Duda: Adult flies of this species were found in cow manure which had been collected in Kailua, Oahu. They were probably attracted to the jar of manure which had been placed outside of the laboratory.

The complete life cycle from egg to adult required about 12 days; the eggs took from 12 to 48 hours for hatching; the larval stage lasted 4 days; and the pupa took about 7 days, an unusually long period of time for the pupal stage, as compared to other species that were reared. This can probably be accounted for by the fact that the pupae were, early in the stage, separated from the substrate to be measured and subsequently placed on moist tissue paper in a petri dish.

The egg (Fig. 2 e) is reticulated, the reticulations being so distinct as to appear punctate. The lateral processes are thin, rather hair-like and arranged like a comb.

The posterior spiracles of the pupa (Fig. 2 f) are projecting and are about 3/5ths as wide as long. The pupal skin is about 2-1/3rds longer than wide.

Sizes of the immature stages: egg, 0.55 mm long, 0.20 mm wide; pupa, 1.90 mm long, 0.69 mm wide.

Leptocera mirabilis (Collin): This species has been bred both from cow and horse manure. Like *L. atomus*, it is frequently seen coming out from beneath manure piles. In the laboratory, it is easily reared in petri dishes containing small amounts of moist horse or cow manure.

Duration of the life cycle varies according to the consistency of the medium. If the manure is constantly kept moist, the life cycle may be completed in as few as 8 days; if the manure is dry, as many as 14 or more days may be required. The egg hatches in about 8 to 24 hours; the larva (Fig. 4 a) takes from 4 to 8 days; and the pupa (Fig. 4 e) requires approximately 3 to 6 days. In one of the rearings, the life cycle was completed

in 8 days.

The eggs (Fig. 4 g) of *L. mirabilis* bear finger-like projections around the anterior end. In the substrate, these processes are exposed and lie parallel to the surface. While the larvae and pupae of this species are similar in shape and relative length of the posterior spiracles to those of *L. brachystoma*, they differ in the serration of the larval mouth hooks and the weaker spines or hooks on the body.

Sizes of the immature stages: egg, 0.41 mm long, 0.11 mm wide; larva (prepupa), 3.5 mm long, 0.65 mm wide; pupa, 2.9 mm long, 0.75 mm wide.

Leptocera atomus (Rondani): This species is found in horse manure. It is found generally underneath or in cracks in the manure pile. When the manure is disturbed, this fly can be seen crawling out from underneath the pile, flying a short distance away, and alighting on blades of grasses nearby. It can be readily collected by placing an open plastic bag or net over the manure pile and gently poking the manure.

The complete life cycle of *L. atomus* requires from 10 to 16 days; the eggs hatch in 12 to 24 hours; the larvae take from 5 to 9 days; and the pupae take from 4 to 7 days.

The eggs (Fig. 6 f) of this species are not reticulated, but have lateral processes which are longest at the anterior end. The mouth hook (Fig. 6 e, g) of the larva is distinctly serrated.

Sizes of the immature stages: egg, 0.38 mm long, 0.11 mm wide; pupa (fig. 6 h), 1.64 mm long, 0.40 mm wide.

Leptocera vagans (Haliday): This species was found to be relatively abundant in cow manure at Waialeale Livestock Research Farm (U. H.). In the same manure piles were found other species of Sphaeroceridae, but in fewer numbers. Precise life cycle data are lacking for this species, although it was bred in cow manure in the laboratory. Adults were introduced into a small bottle, $\frac{1}{4}$ th filled with boiled manure, and were left in the bottle for 5 days. Sixteen days following the initial introduction into the jar, adults began to emerge. If the ♀ oviposited on the day of introduction, as is assumed, then the life cycle took approximately 16 days.

Life cycle and immature stages of the remaining species which are listed below are not available. However, they are included here as apparently breeding in manure (horse or cow), since they were obtained as they emerged from manure in laboratory rearing jars.

Copromyza sordida (Zetterstedt). A ♂ and a ♀ emerged from horse manure. They were subsequently found to be infested with nematodes when I tried to breed them in a separate rearing jar.

Leptocera punctipennis (Wiedemann). More than 10 flies of this species emerged from cow manure in the laboratory. In the field in Kailua, Oahu and Kohala Mts., Hawaii, it was observed to be relatively abundant.

Leptocera pectinata sp. n. This species is fairly abundant in cow manure

and a long series was collected from Kailua, Oahu. In the laboratory, several eggs (Fig. 3 b) were obtained, but they did not hatch. The features of the eggs of this species are quite distinct from the egg of *L. brevicostata* var. *rufifrons* Duda (Fig. 2 e).

Leptocera obliqua Richards. A ♂ and two ♀ of this fly were collected as they emerged from horse manure in the laboratory.

Leptocera acutangula (Zetterstedt). A long series of both sexes of this species were collected from horse manure soon after they emerged. It was observed to be very abundant on horse manure in Kailua, Oahu, for the month of November.

Leptocera ferruginata (Stenhammar). Eight males and 11 females emerged from cow manure. It was found also in association with *L. vagans* and *L. hirtula* in manure at Waialeale, Oahu.

Leptocera hirtula (Rondani). This species was bred from cow manure in the laboratory and also collected from field manure.

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